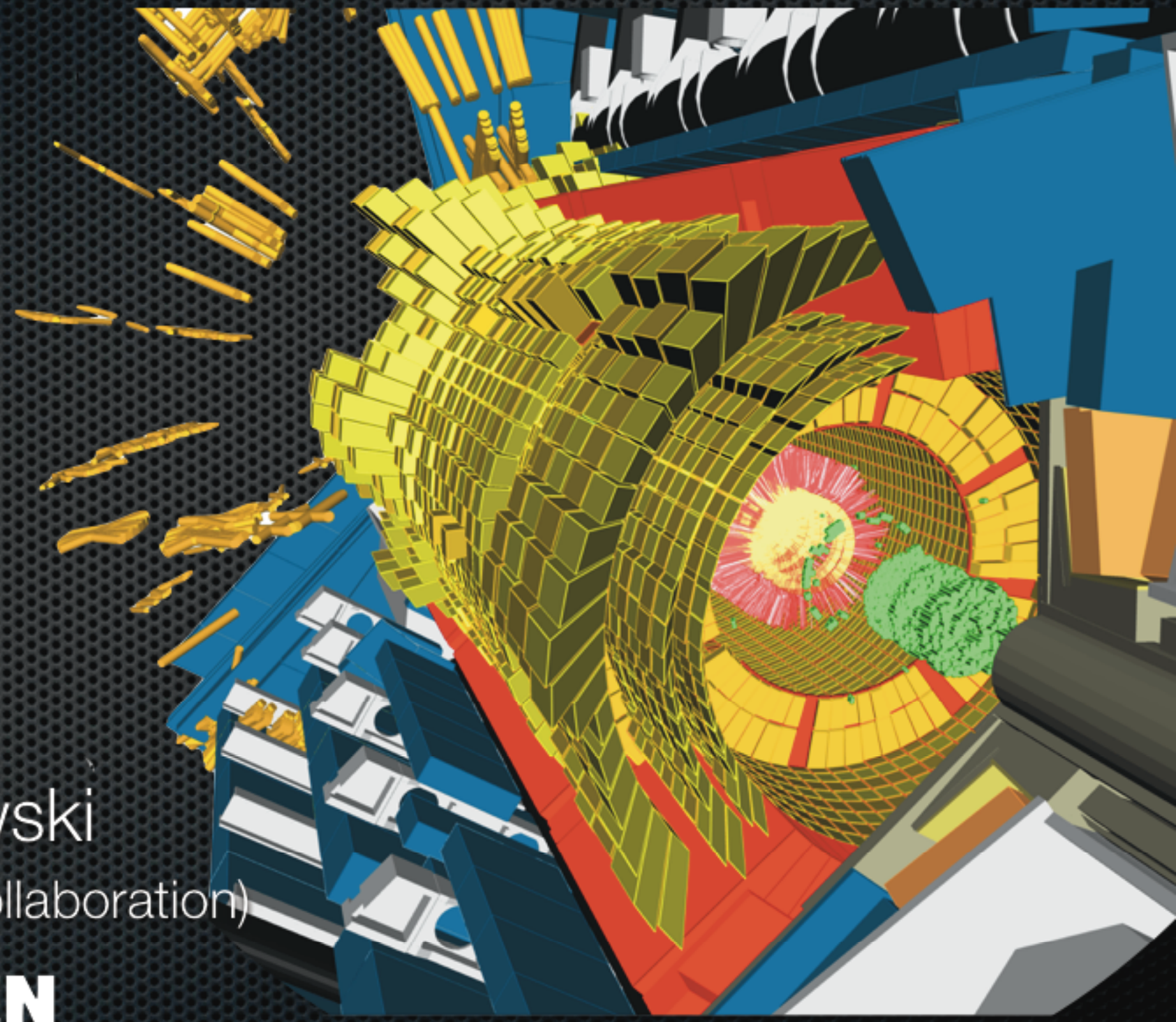
Early Data-Taking with **ATLAS**



Stephanie Majewski

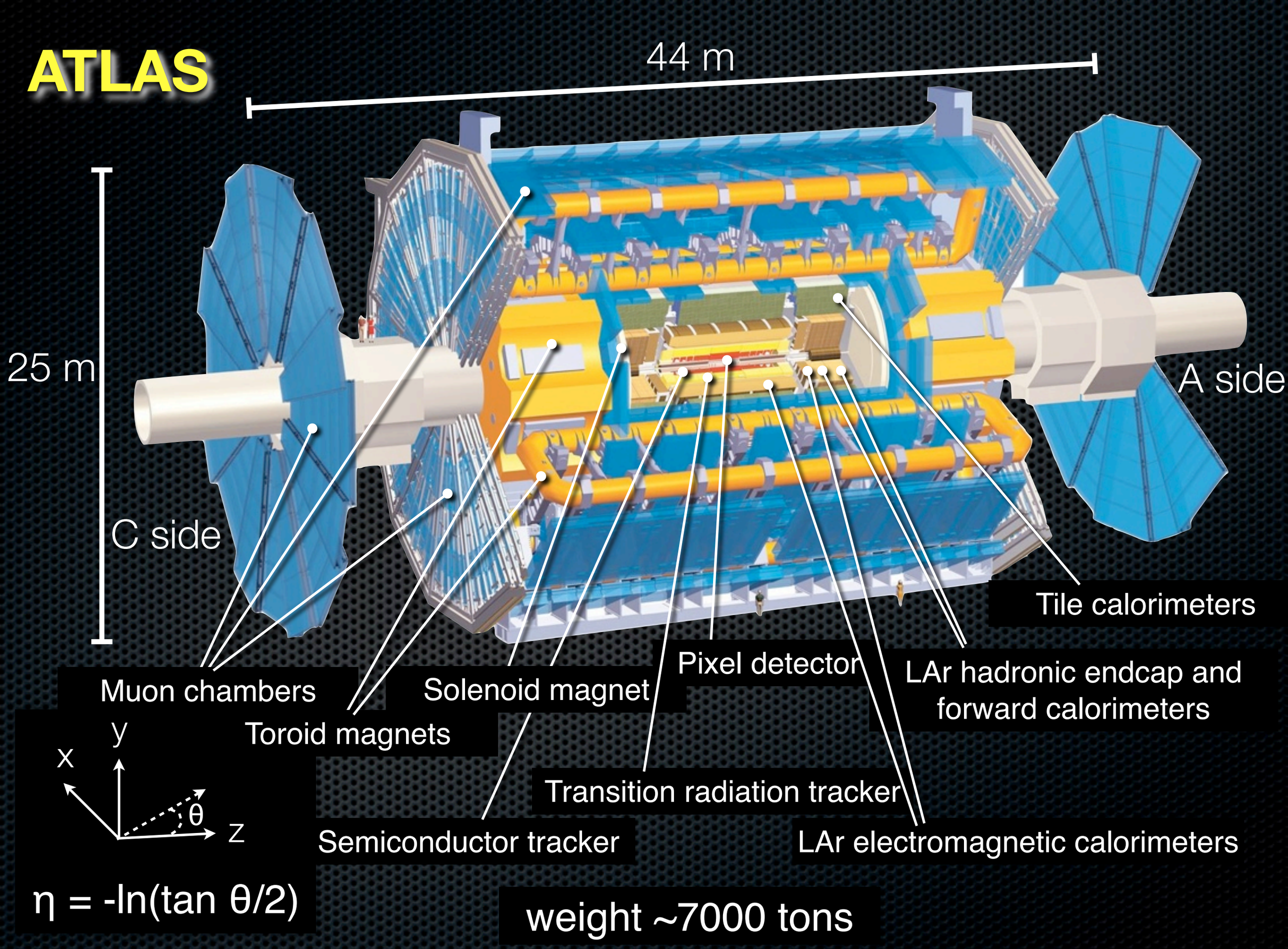
(on behalf of the ATLAS Collaboration)

BROOKHAVEN NATIONAL LABORATORY

LHC@BNL, 8 Feb 2010

- Introduction
- Trigger Commissioning
- Muon Spectrometer Performance
- Inner Detector Performance
- Performance of the Electromagnetic and Hadronic Calorimeters
- Summary and Outlook

ATLAS


44 m
25 m
A side
C side
Muon chambers
Toroid magnets
Solenoid magnet
Pixel detector
Tile calorimeters
LAr hadronic endcap and forward calorimeters
Transition radiation tracker
Semiconductor tracker
LAr electromagnetic calorimeters
y
x
θ
z
η = -ln(tan θ/2)
weight ~7000 tons

ATLAS

44 m

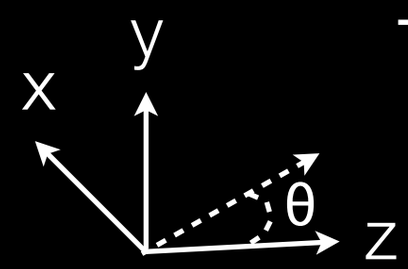
25 m

C side

A side

Muon chambers

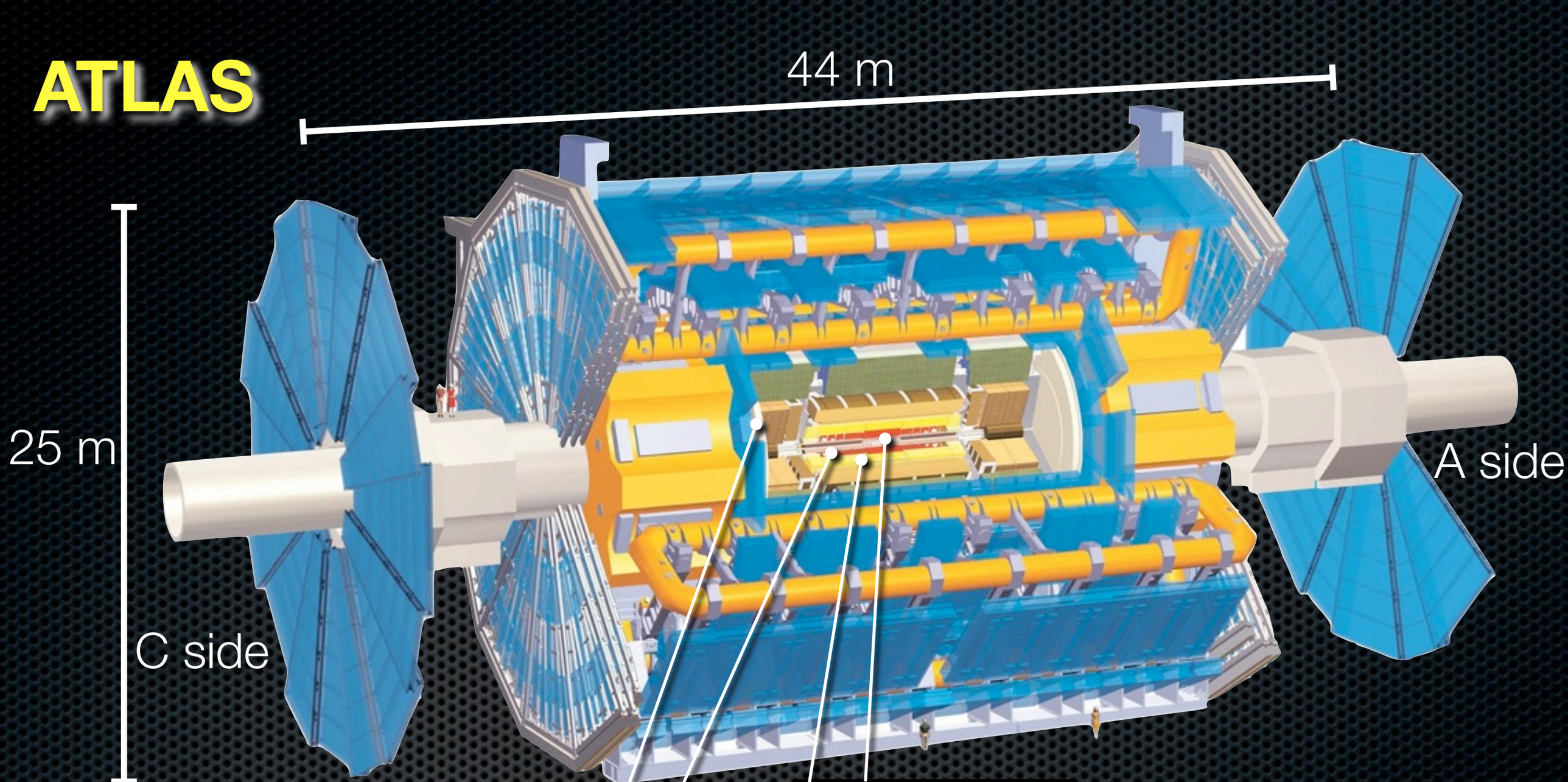
Toroid magnets

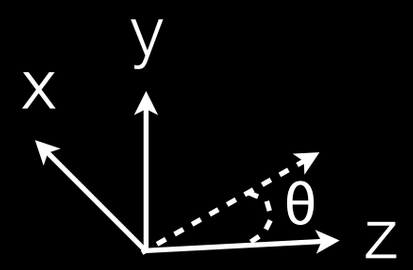


$\eta = -\ln(\tan \theta/2)$

weight ~7000 tons

ATLAS





$\eta = -\ln(\tan \theta/2)$

weight ~7000 tons

ATLAS

44 m

25 m

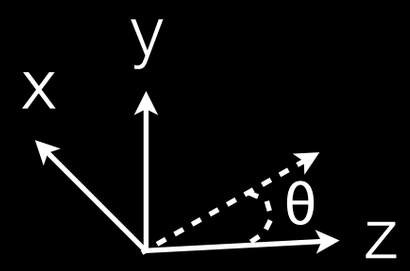
C side

A side

Tile calorimeters

LAr hadronic endcap and forward calorimeters

LAr electromagnetic calorimeters



$\eta = -\ln(\tan \theta/2)$

weight ~7000 tons

Detector Hardware Status

Subdetectors operational 98-100% of the time

Subdetector	# Channels	Operational Fraction
Pixel detector*	80 M	97.9%
SCT Silicon strip detector*	6.3 M	99.3%
TRT Transition Radiation Tracker	350 k	98.2%
LAr EM Calorimeter	170 k	98.8%
LAr Hadronic Endcap Calorimeter	5600	99.9%
LAr Forward Calorimeter	3500	100%
Tile Calorimeter	9800	99.2%
MDT Muon Drift Tubes	350 k	99.7%
CSC Cathode Strip Chambers	31 k	98.4%
RPC Barrel Muon Trigger	370 k	98.5%
TGC Endcap Muon Trigger*	320 k	99.4%
Level 1 Calo Trigger	7160	99.8%

*detector not fully on or at reduced voltage when no stable beam

Timeline

2009

20 Nov — Beam at ATLAS

23 Nov — First Collisions at √s = 900 GeV

First Stable Beams (Trackers ON)

6 Dec

8 Dec — First Collisions at √s = 2.36 TeV

14 Dec

16 Dec — Collisions at √s = 2.36 TeV

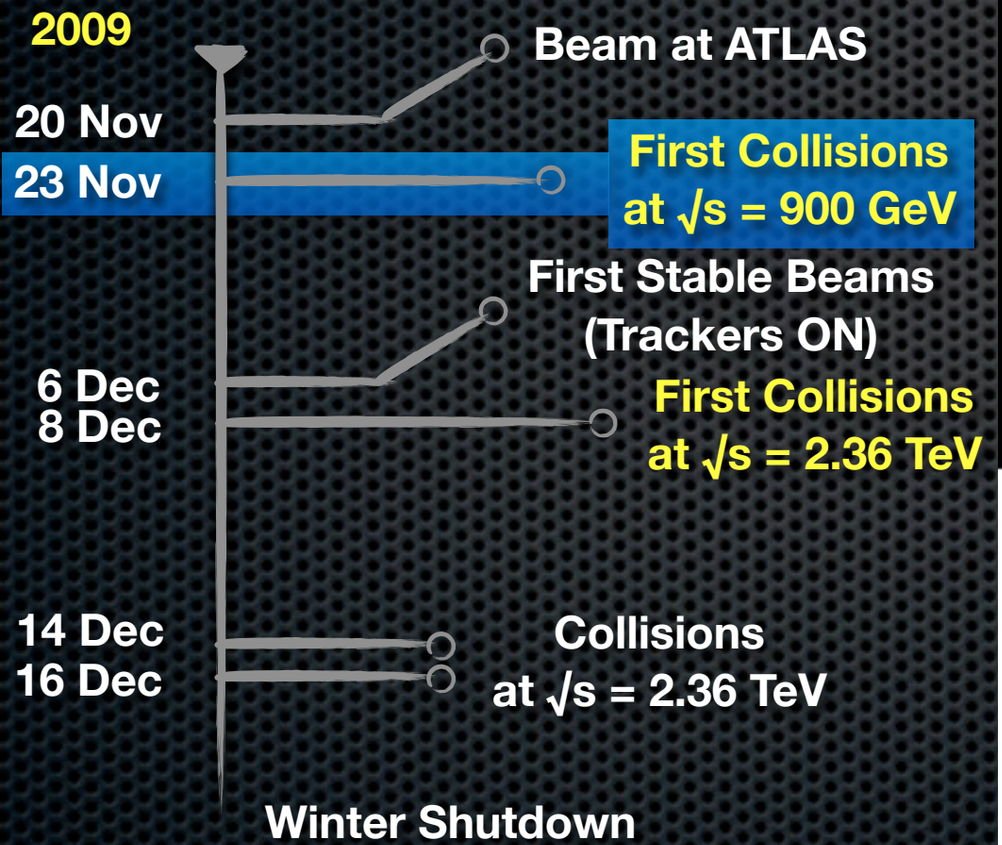
Winter Shutdown

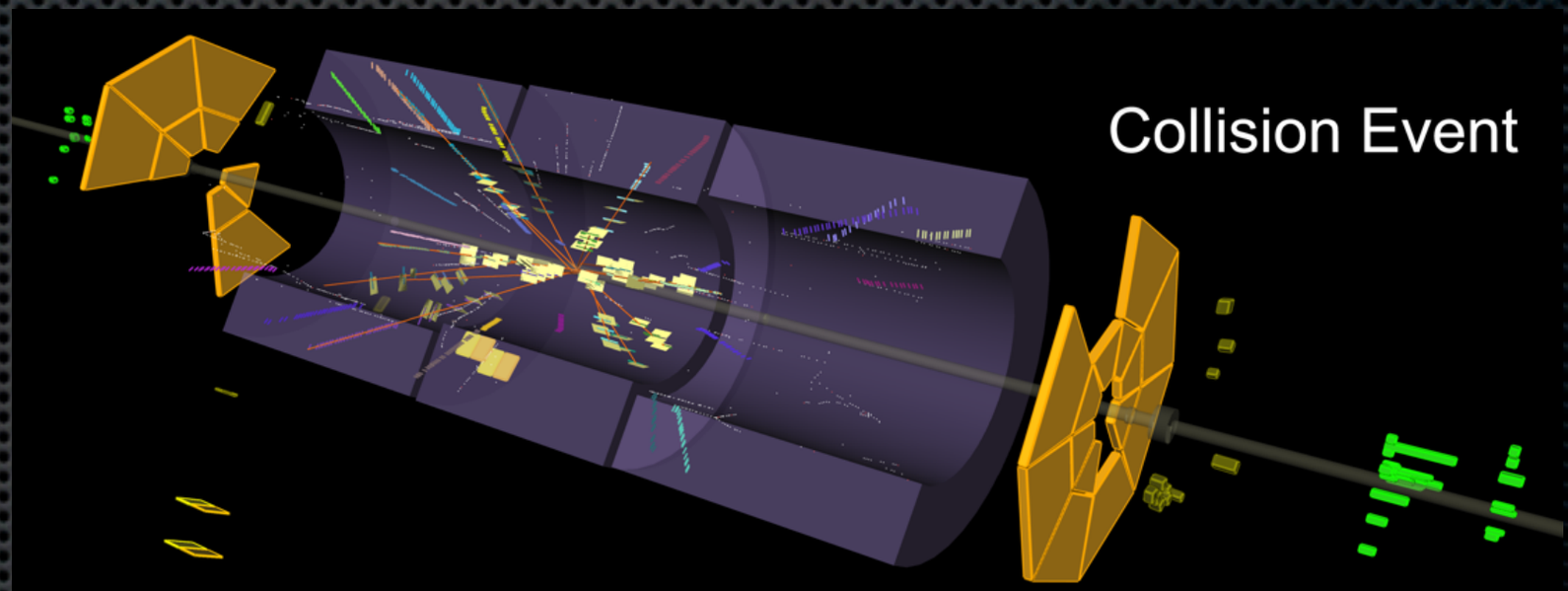
2010

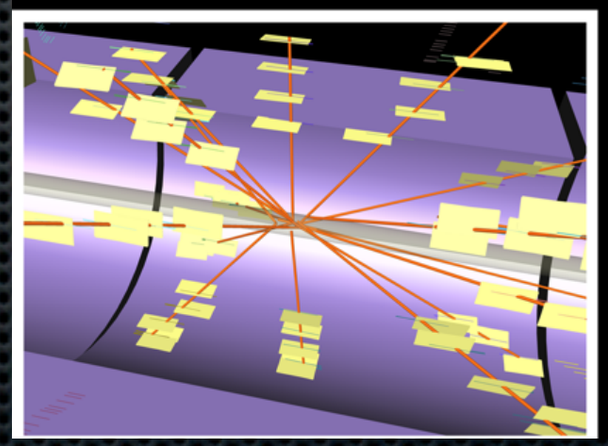
~15 Feb — Return of LHC Operations (expected √s ~ 7 TeV)

First Collisions at $\sqrt{s} = 900$ GeV

- First collision observed at 14:22, 23 November 2009
- ATLAS recorded ~200 collision candidate events

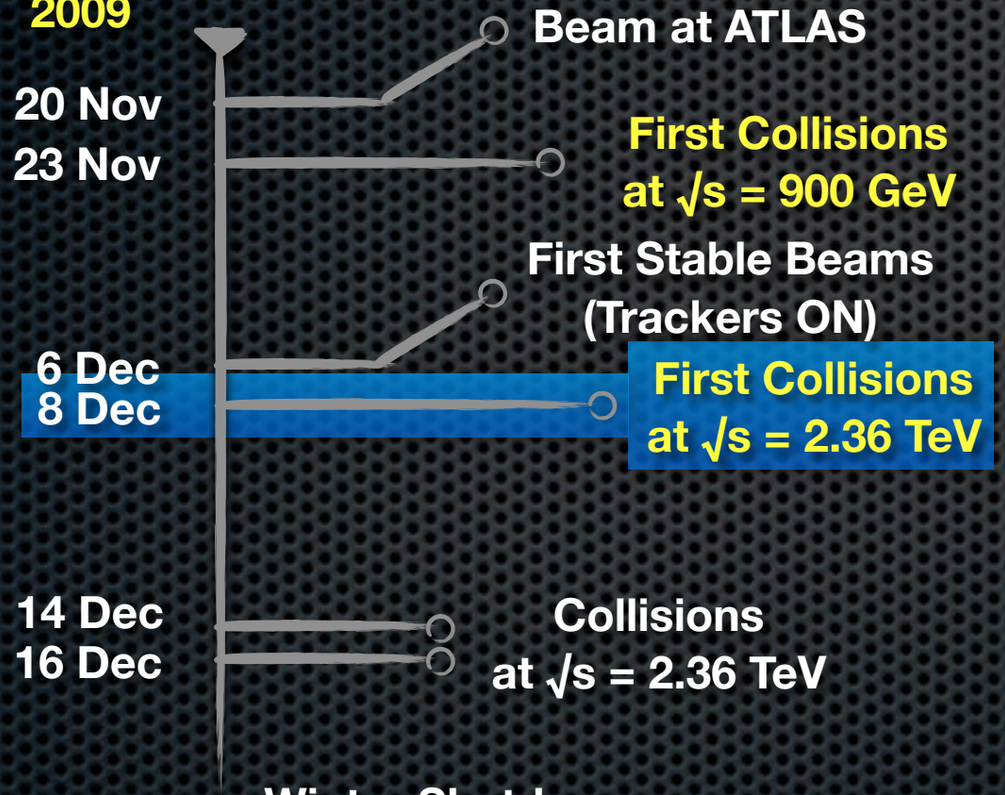


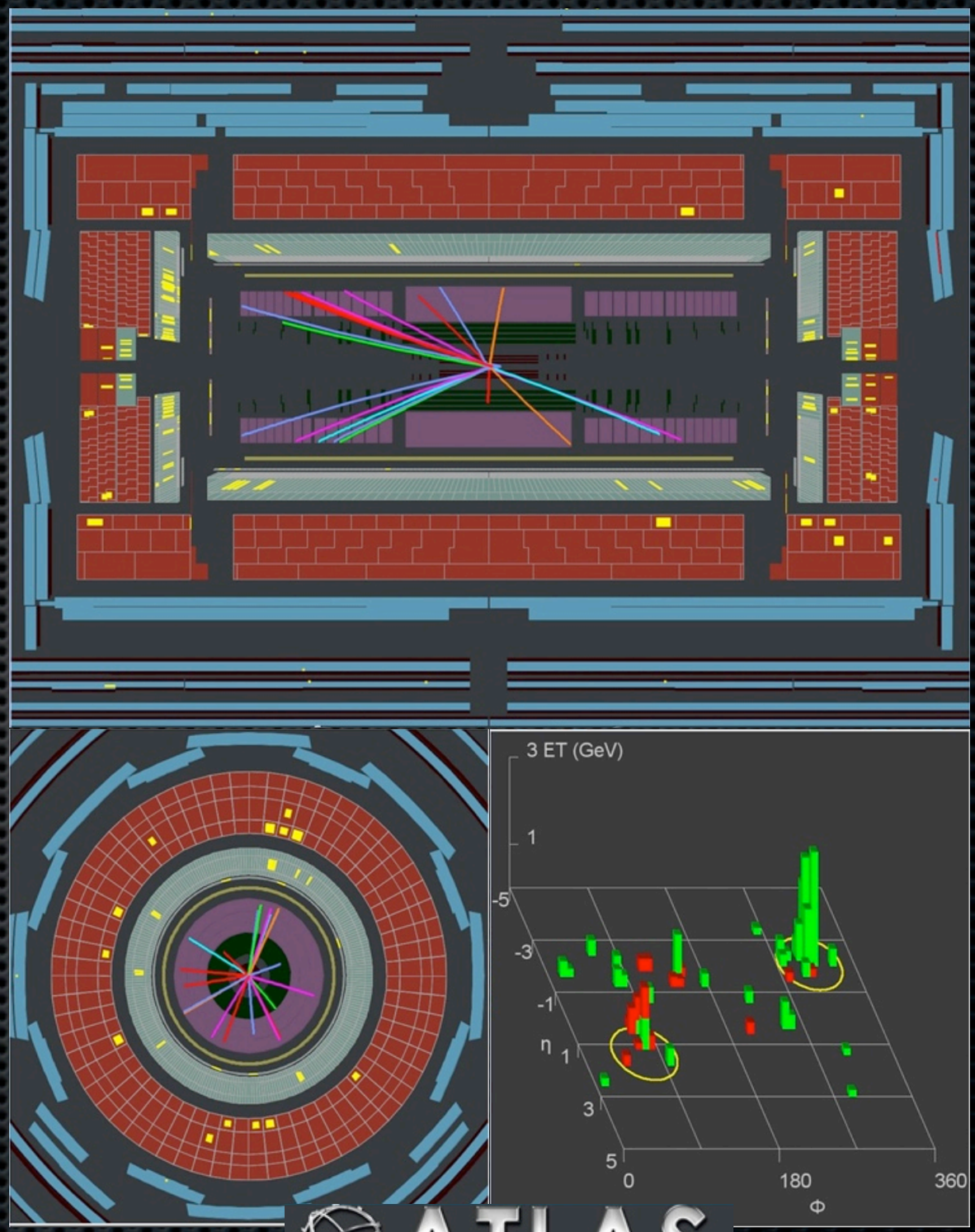


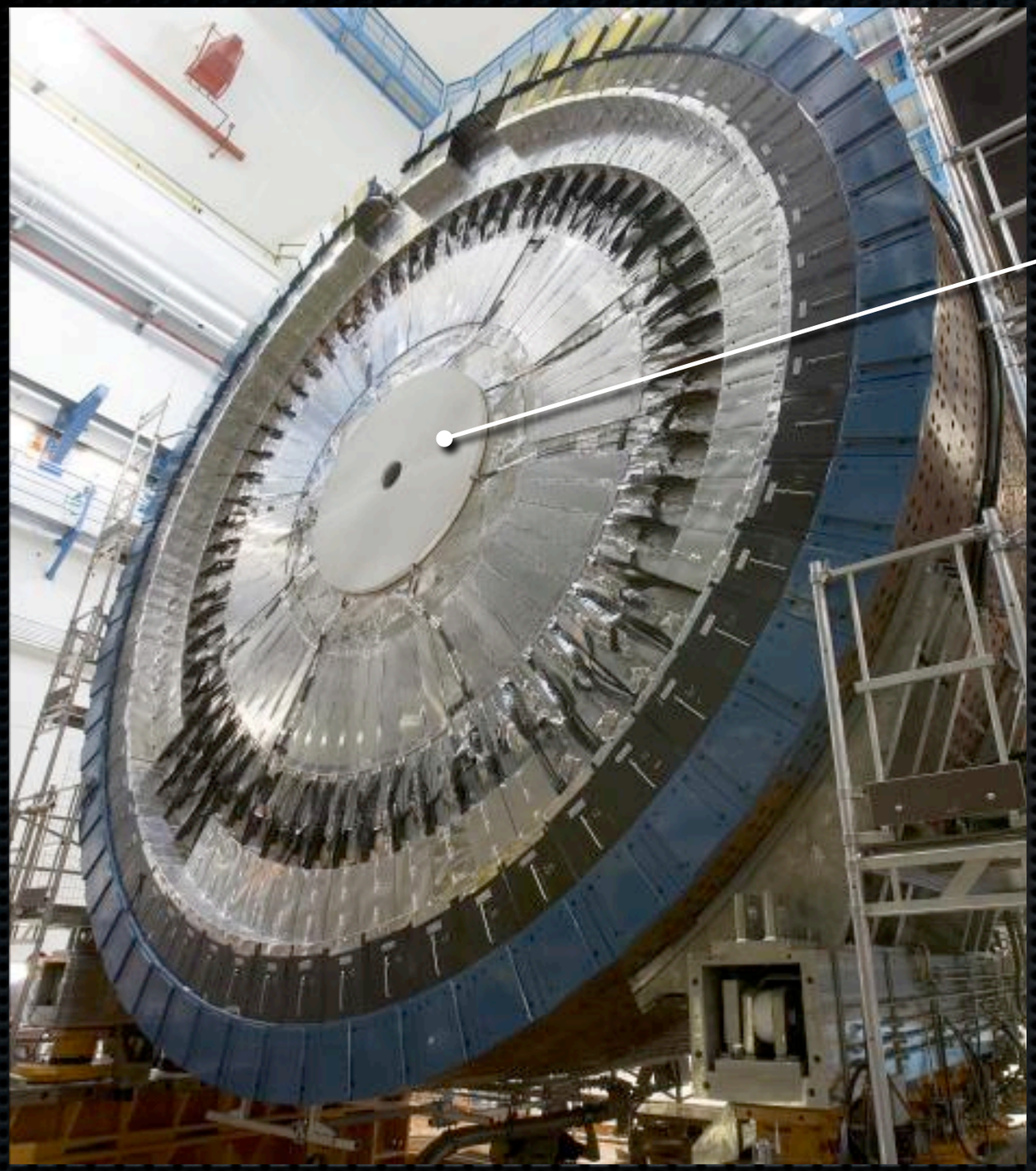


Jet Event at $\sqrt{s} = 2.36$ TeV

http://atlas.web.cern.ch/Atlas/public/EVTDISPLAY/events.html







Minimum Bias Trigger Scintillator (MBTS), $2.09 < |\eta| < 3.84$

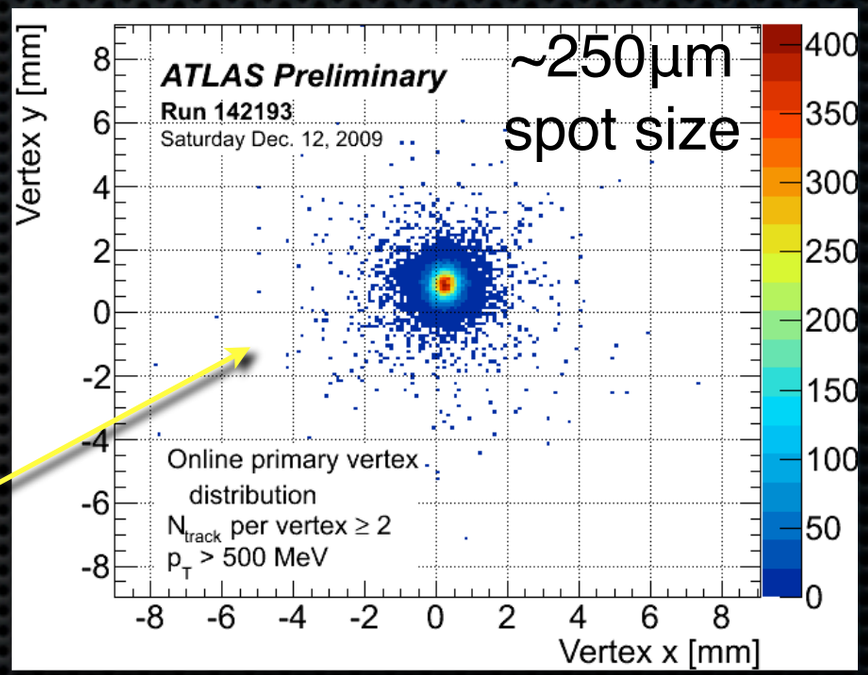
mounted on the LAr endcap cryostat

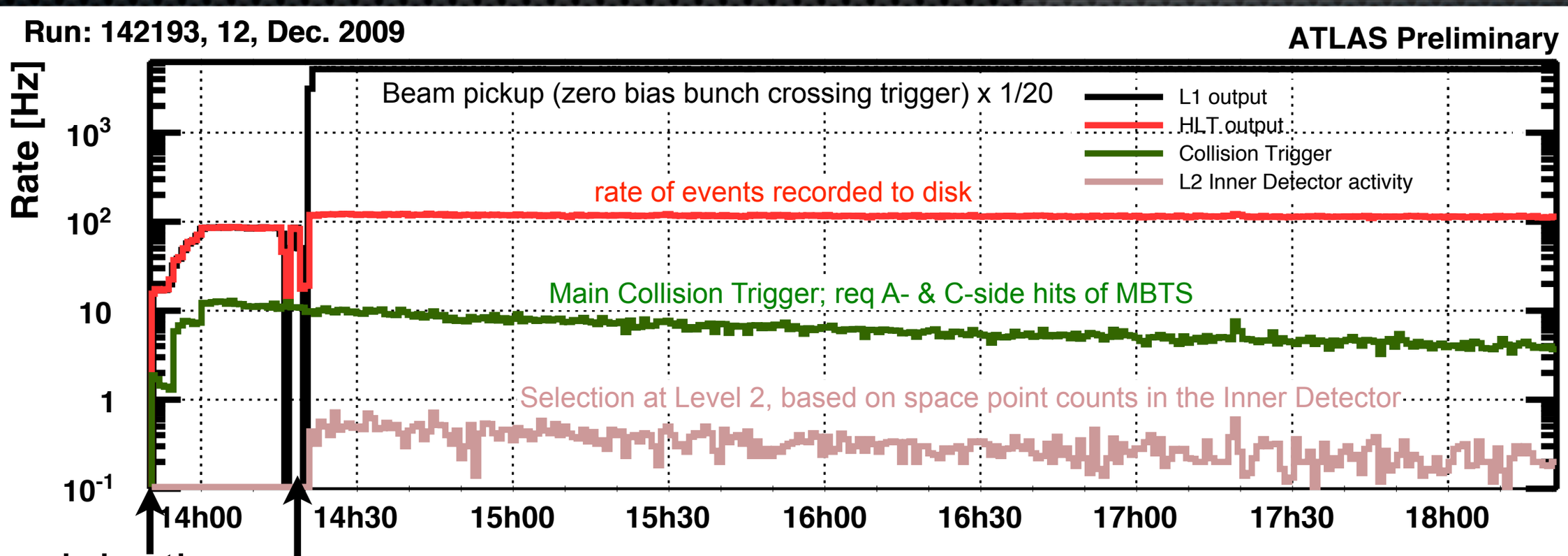
Trigger Commissioning

Early Data, Low-Luminosity

Trigger Commissioning

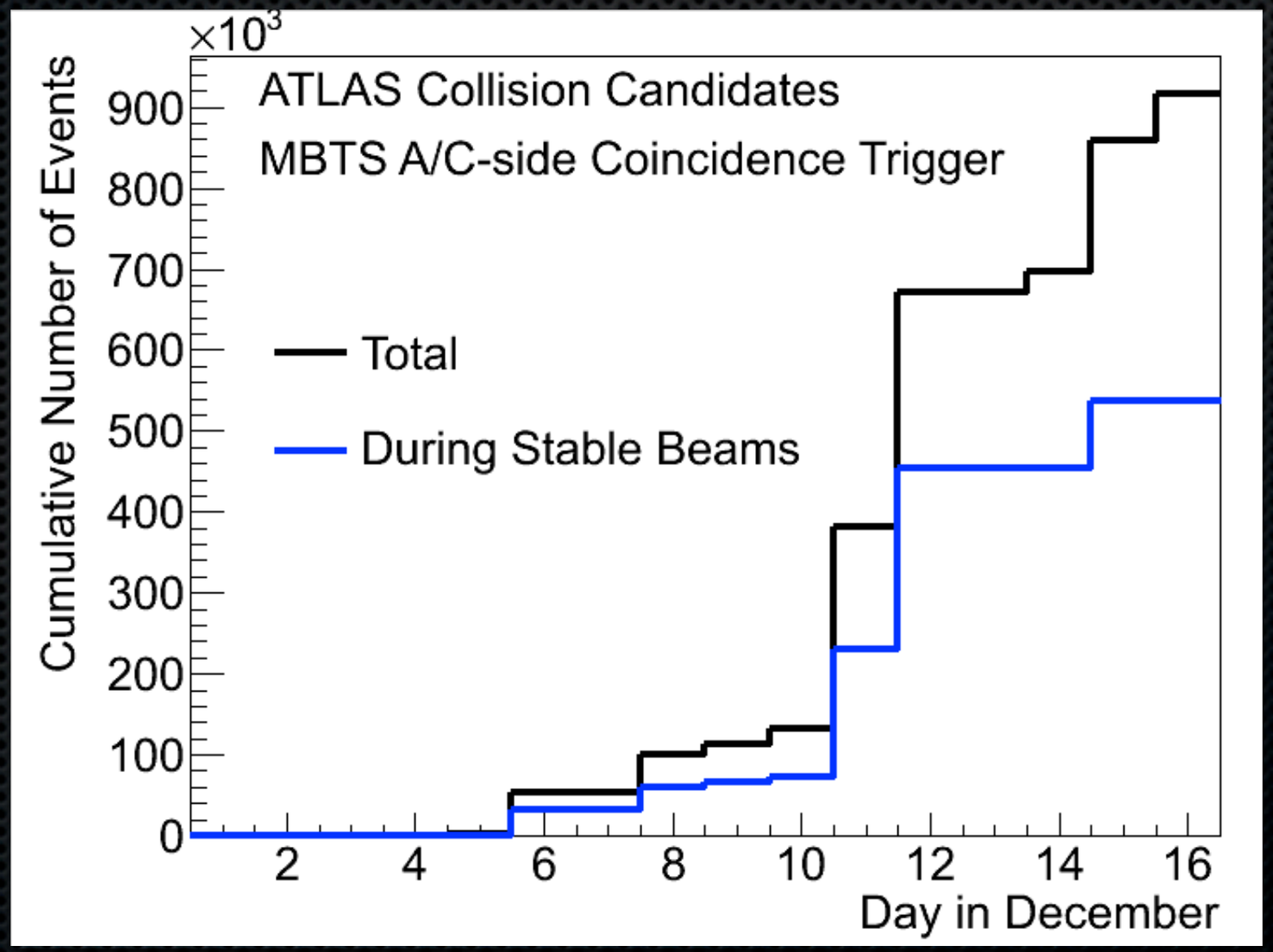
- MBTS main Level 1 trigger for collisions in December run
- Other L1 triggers active (256 incl. calo, muon)
- Online beamspot monitoring





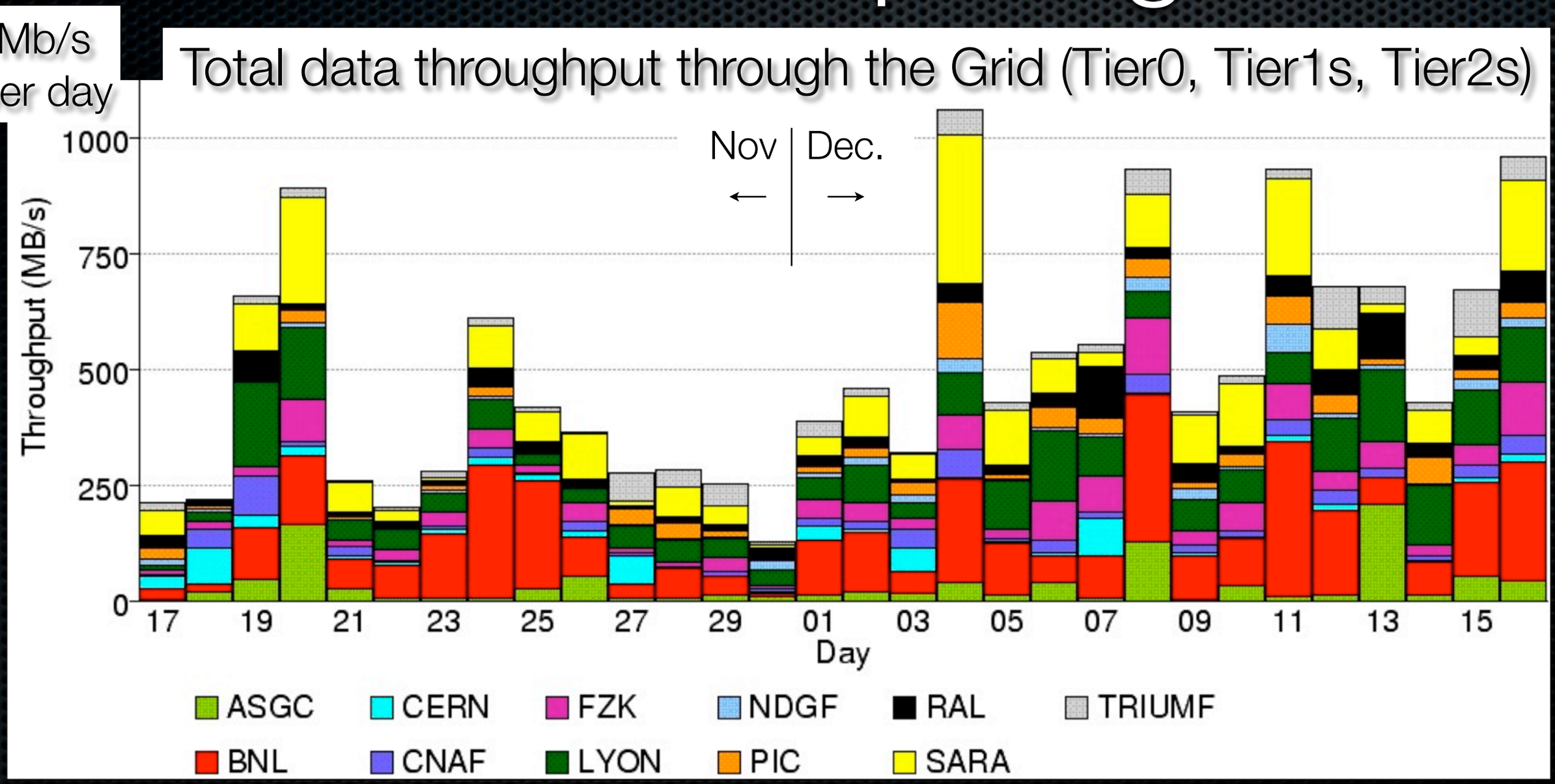
- Total # Collision Candidates: **917k** (**~20μb^{-1}**)
- Total during Stable Beams: **538k** (**~12μb^{-1}**)
- Total at $\sqrt{s}$ = 2.36 TeV: **34k**
- Data-Taking Efficiency: **~90%**

$\sigma_{\mathcal{L}umi} < 30\%$

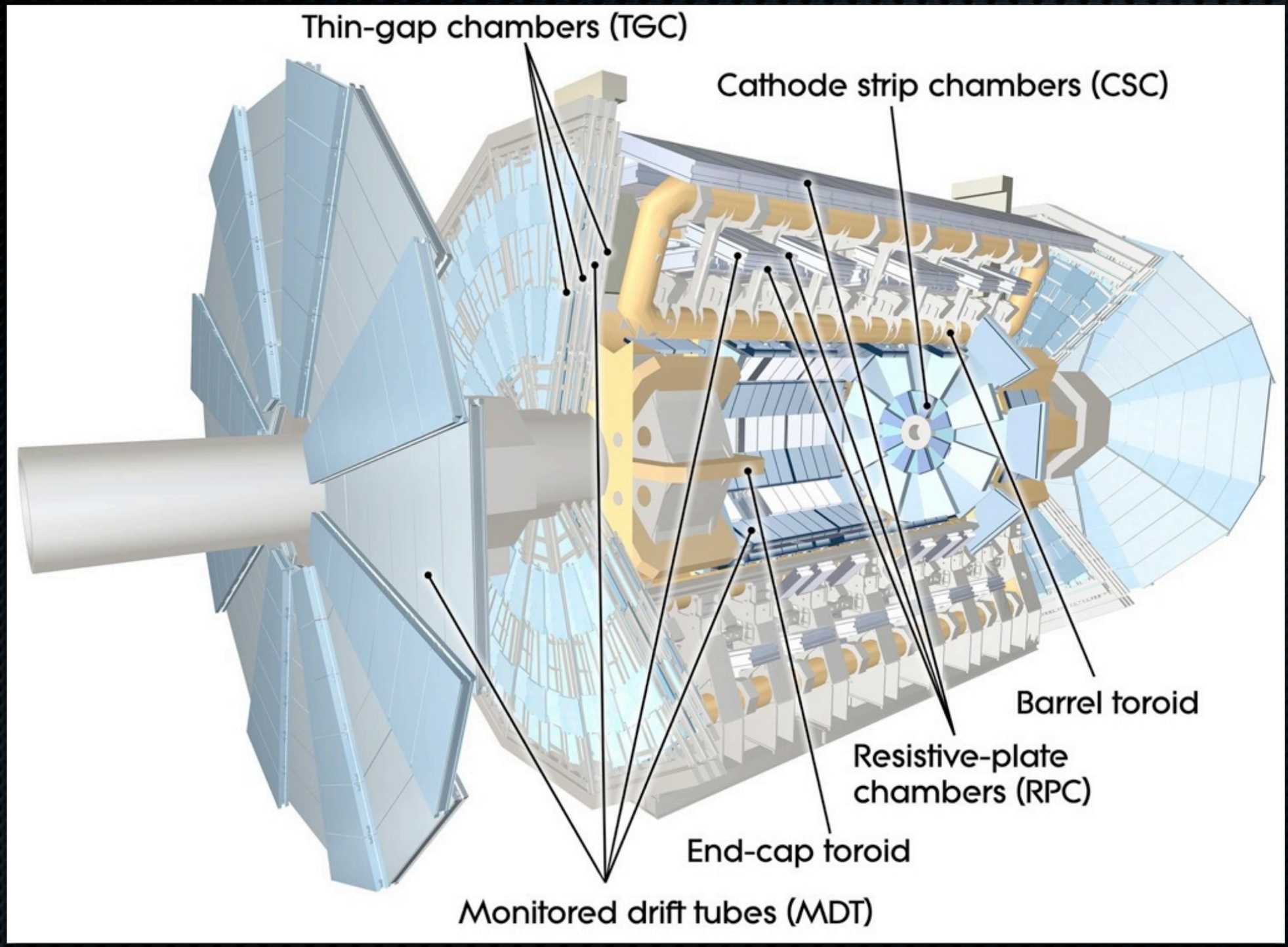


Distributed Computing

Distributed Computing



- 200 Tb of data recorded
- Prompt reconstruction at CERN Tier0
- Data available at Tier2s for analysis within 8 hours



Muon Spectrometer

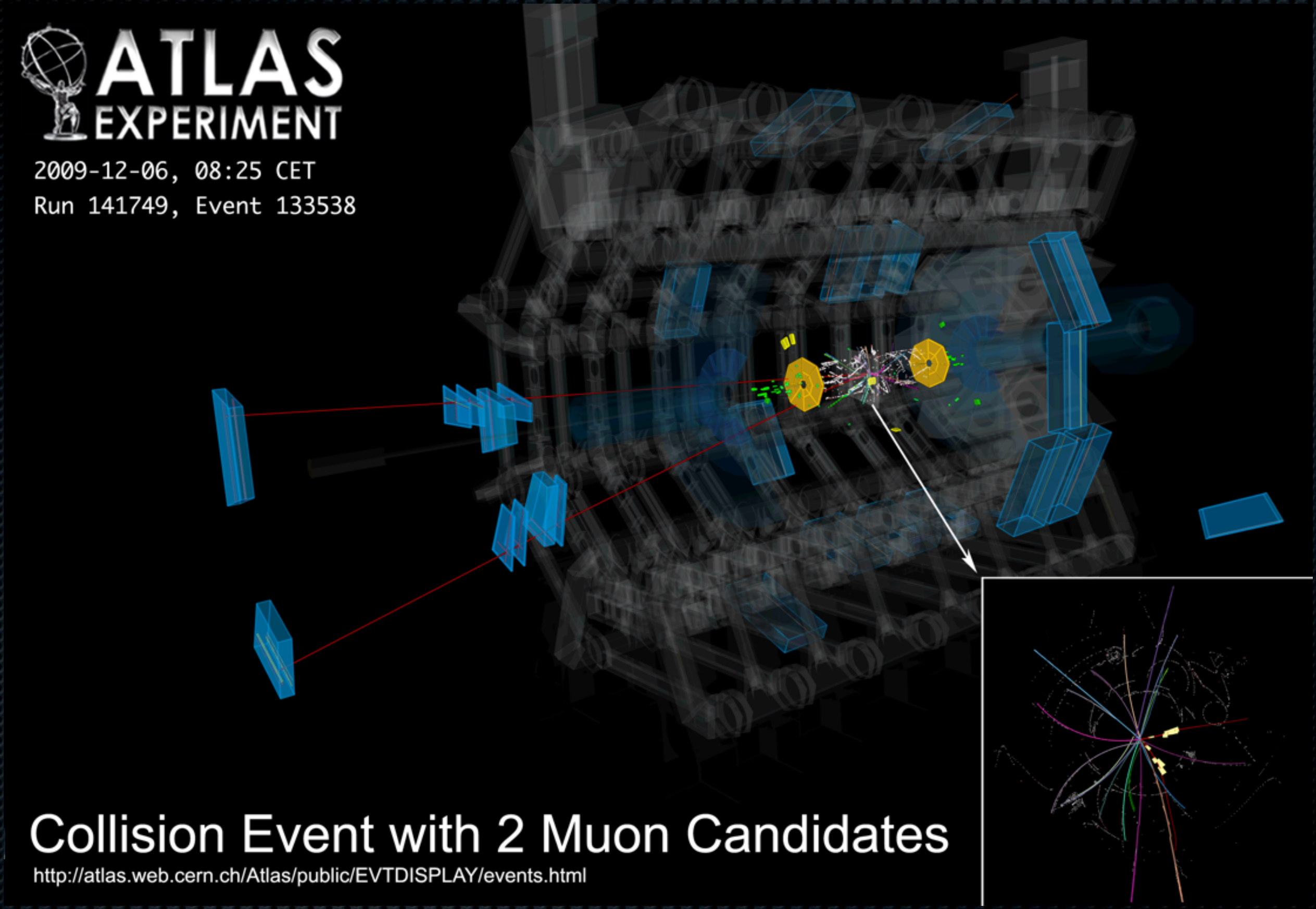
Muon chambers plus toroid magnets

toroid magnets off

ATLAS EXPERIMENT

2009-12-06, 08:25 CET

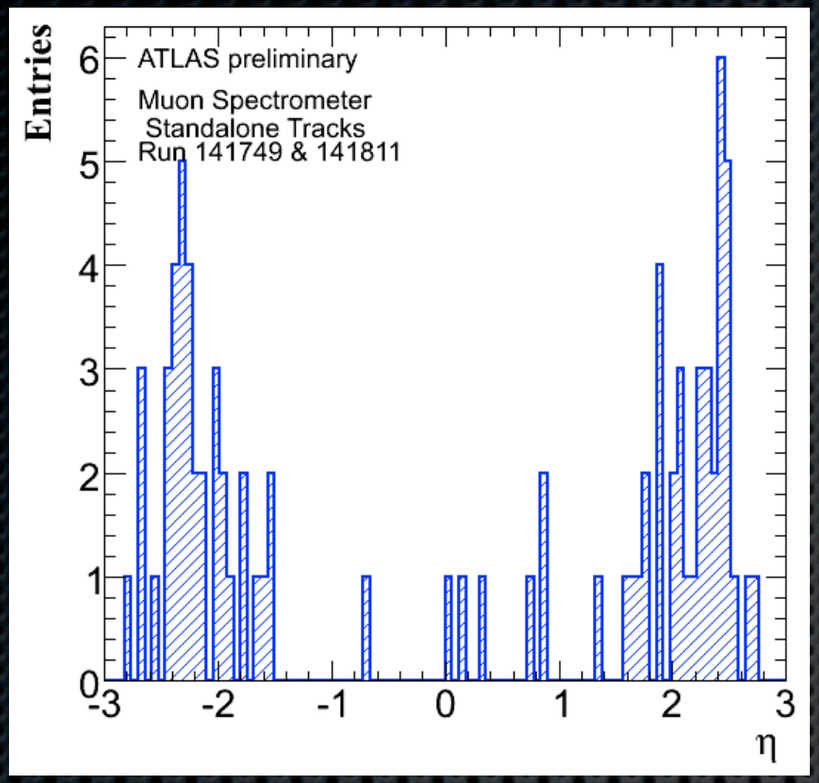
Run 141749, Event 133538



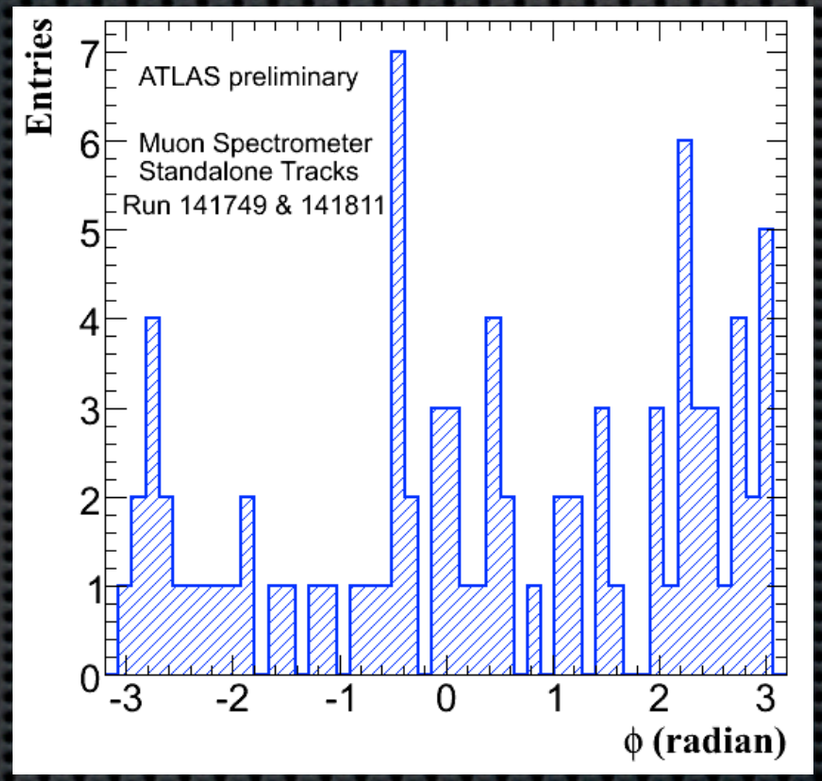
Collision Event with 2 Muon Candidates

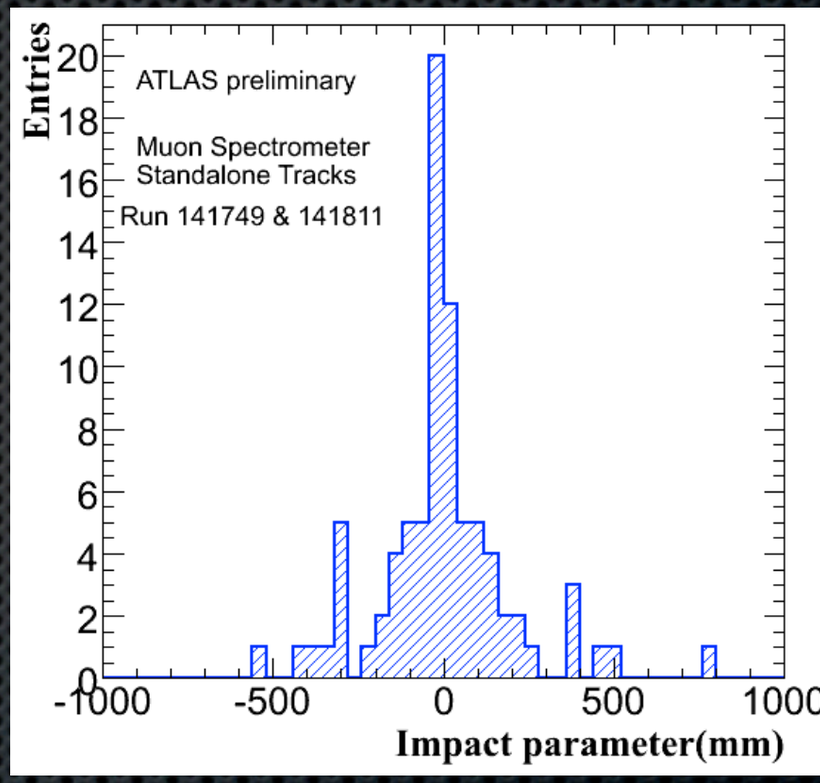
http://atlas.web.cern.ch/Atlas/public/EVTDISPLAY/events.html

Muons in Collision Events



distribution peaked at large **η**
(consistent with minimum bias p-p collisions)

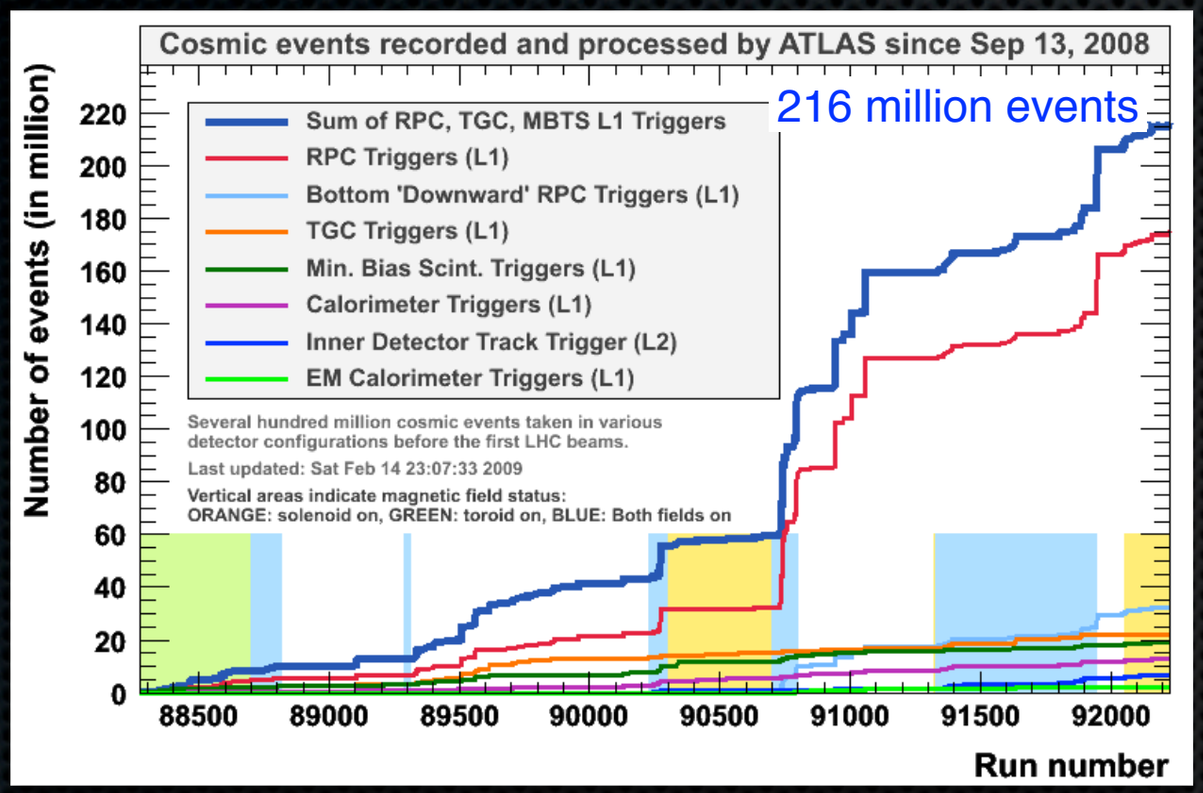




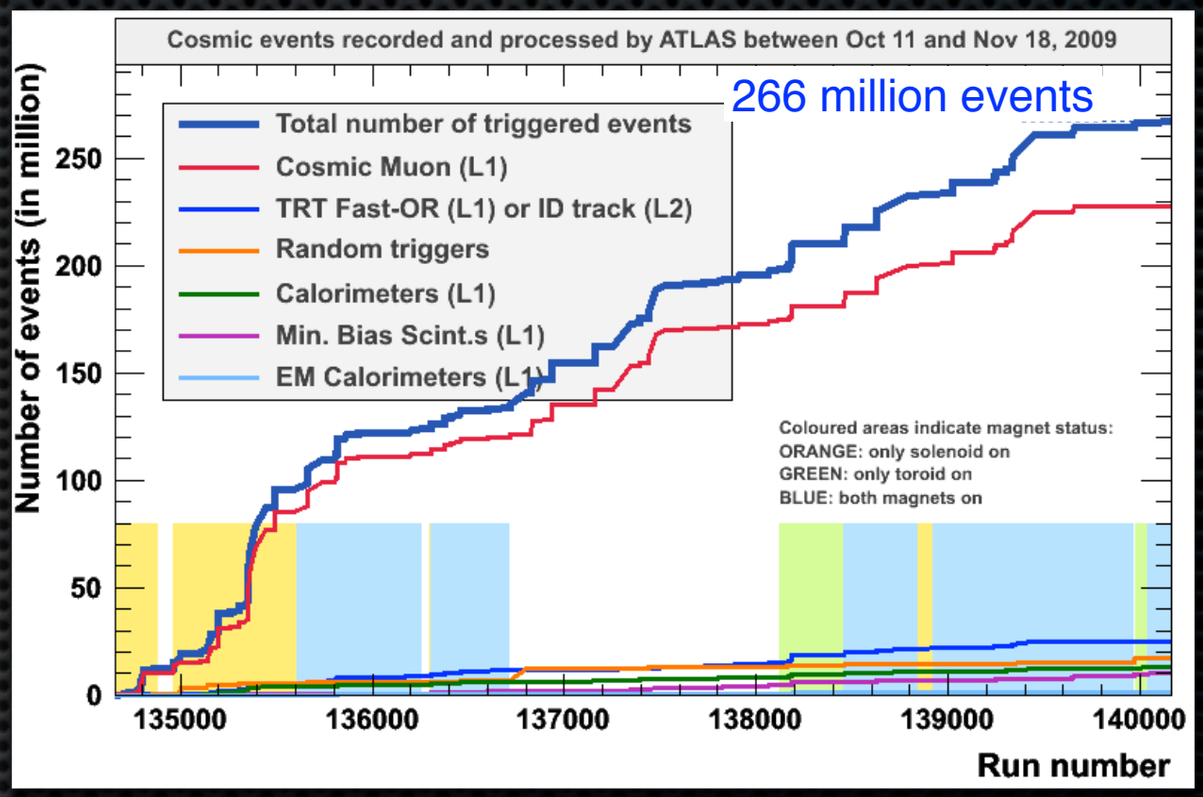
expected width ~200 mm
(consistent with multiple scattering of ~3 GeV muons)

Combined Cosmics Data

2008



2009

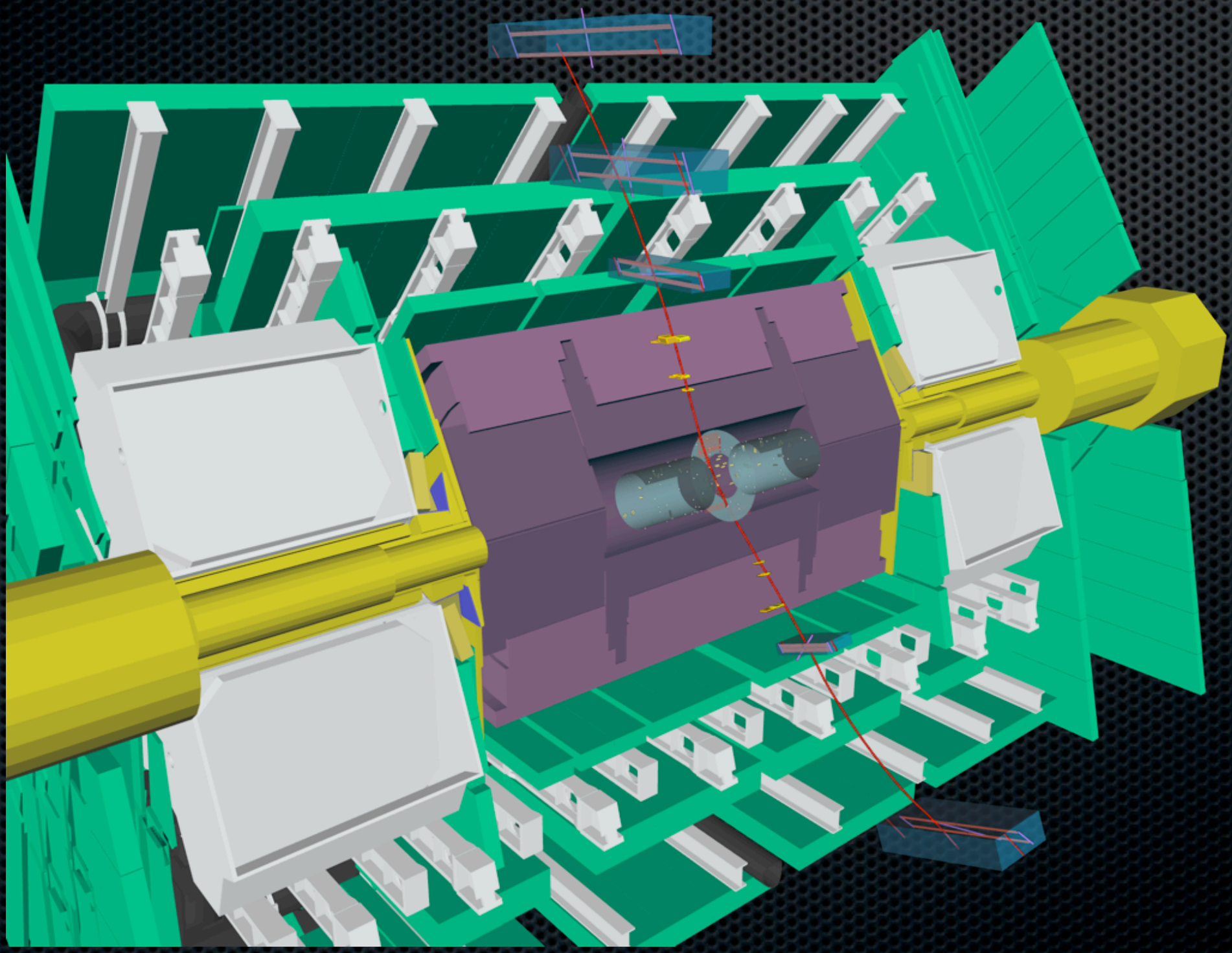


+93M events in Summer 2009

Large cosmic muon sample used to begin to commission subdetectors

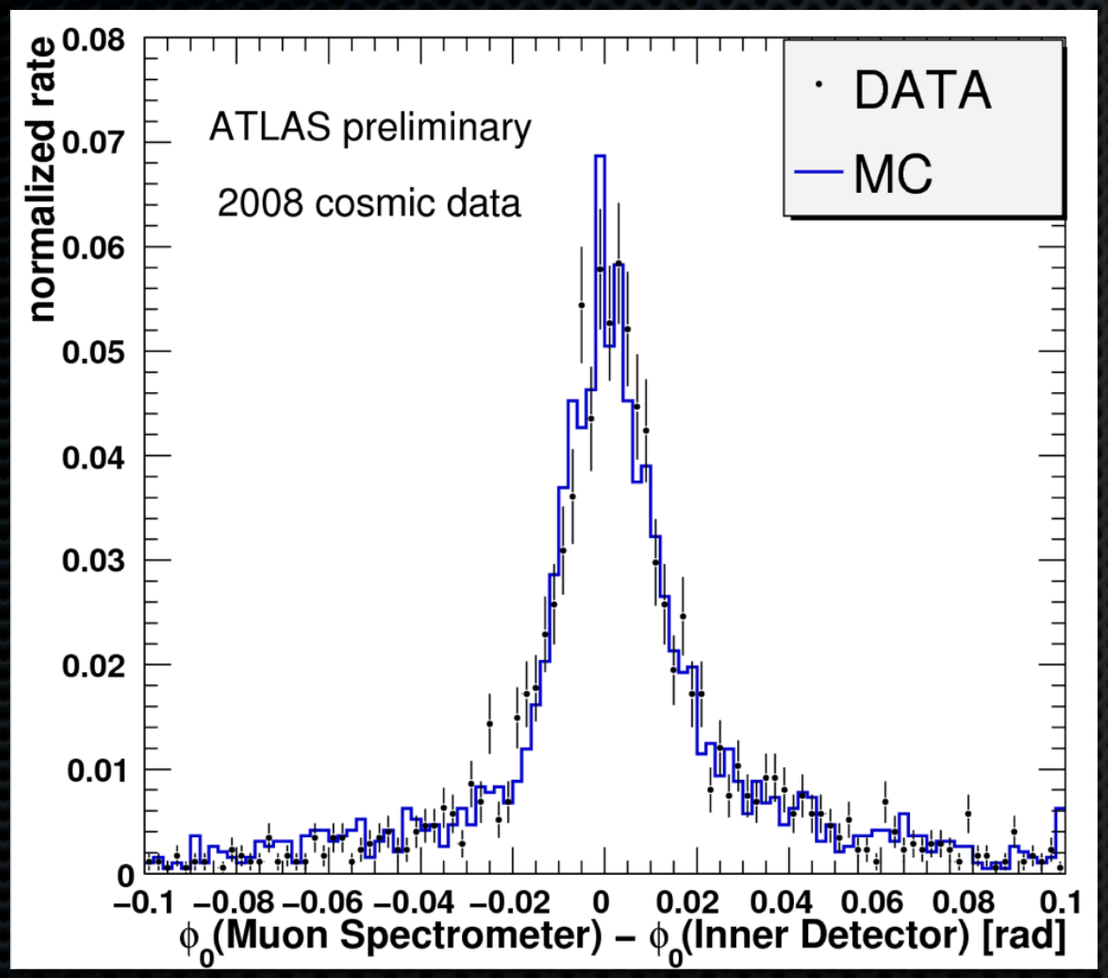
Muon Performance

many studies already done using cosmic muons

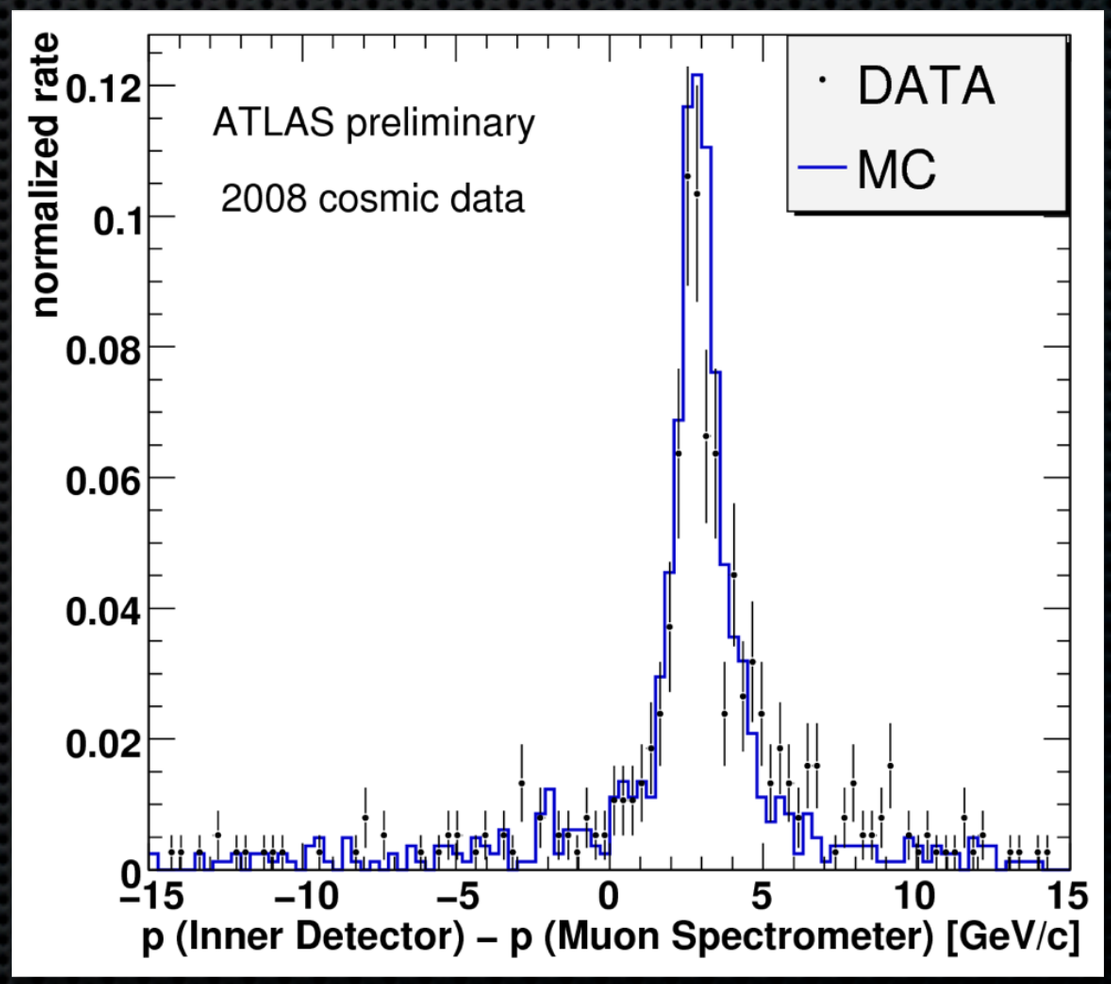


Muon Performance

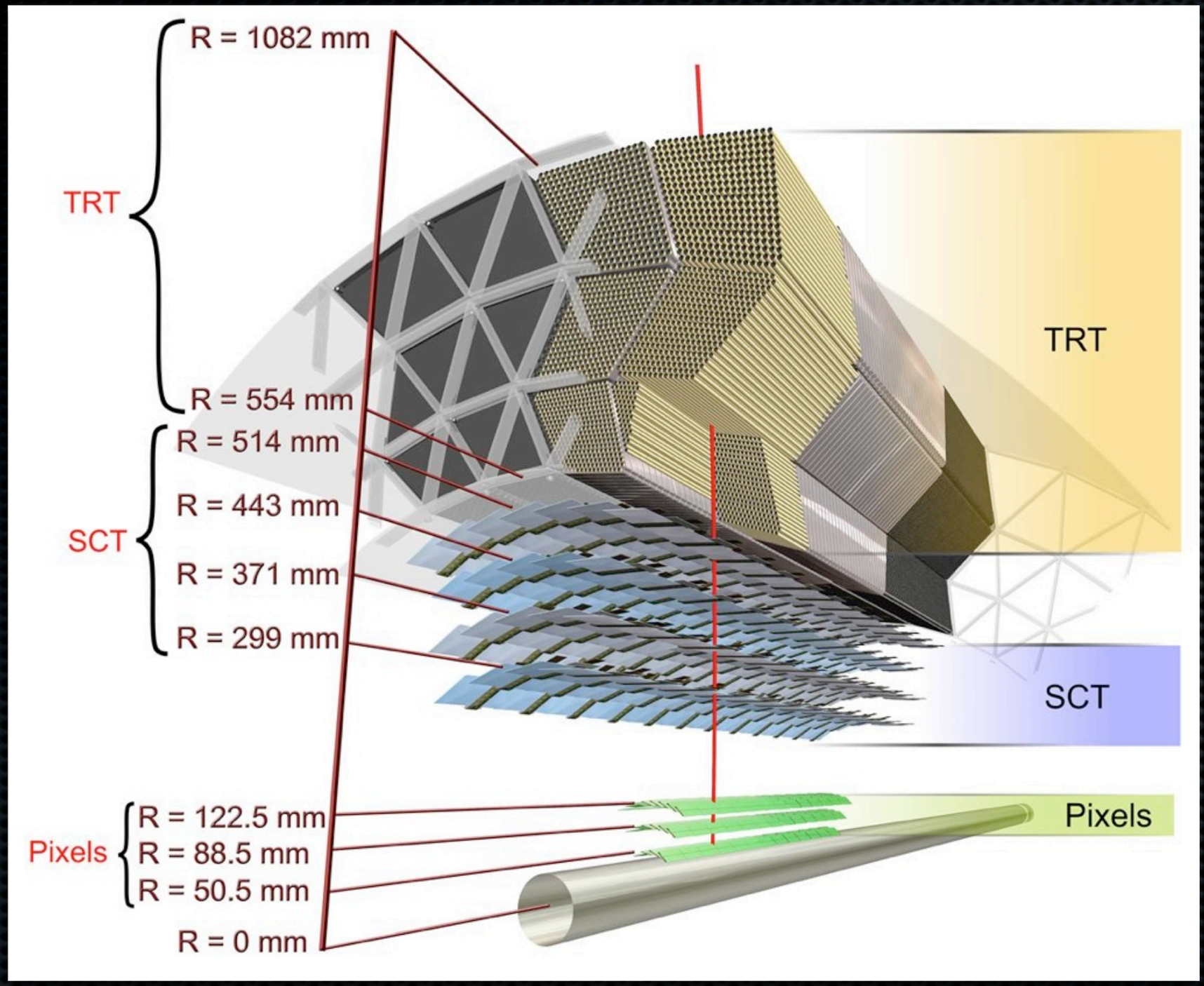
many studies already done using cosmic muons



alignment between muon spectrometer and inner detector



muon energy lost in the calorimeters

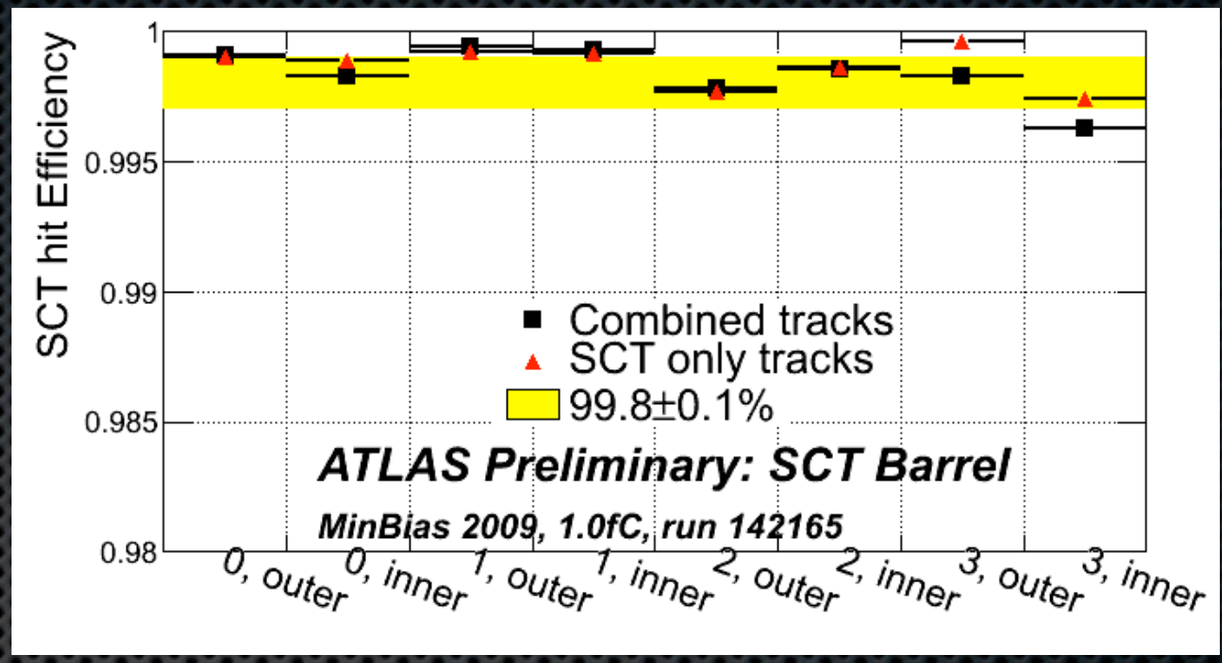


Inner Detector

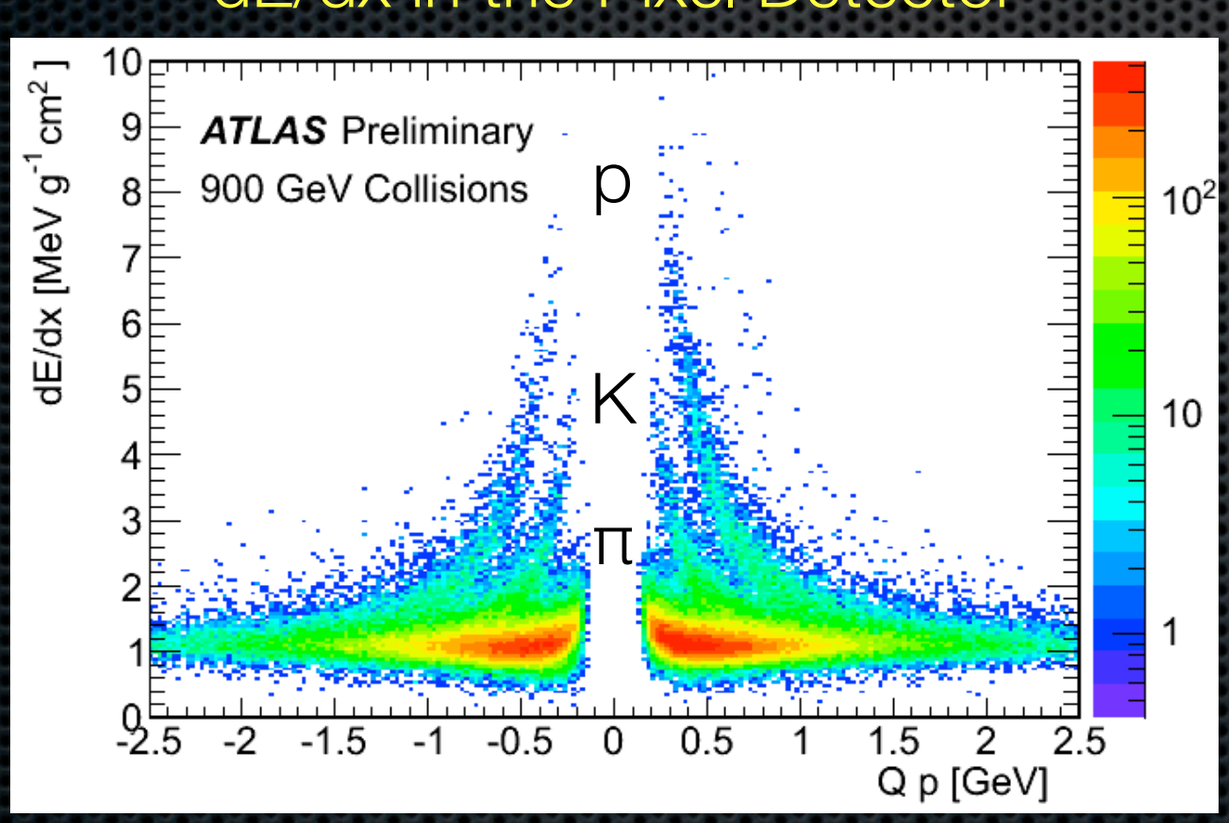
in a 2T solenoid field

Performance with 900 GeV Collisions

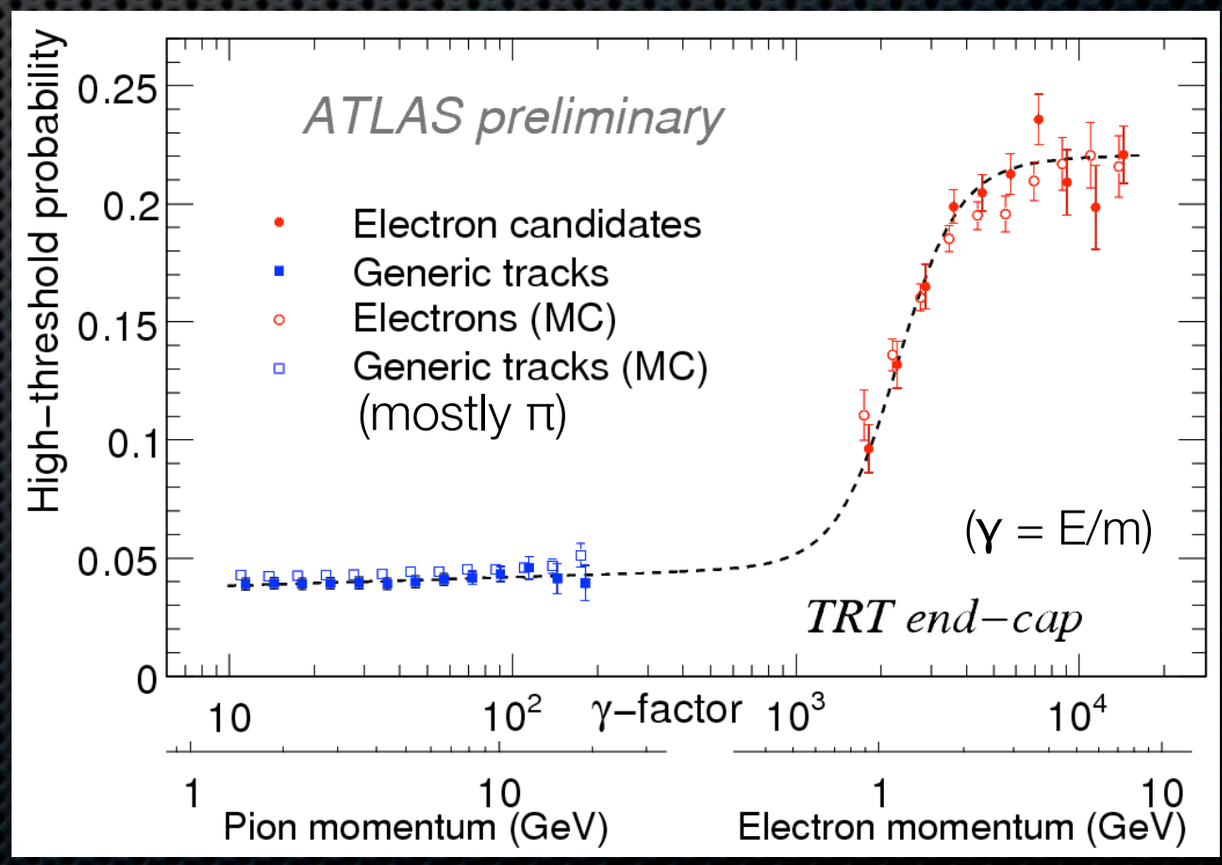
Semiconductor Tracker Hit Efficiency



dE/dx in the Pixel Detector

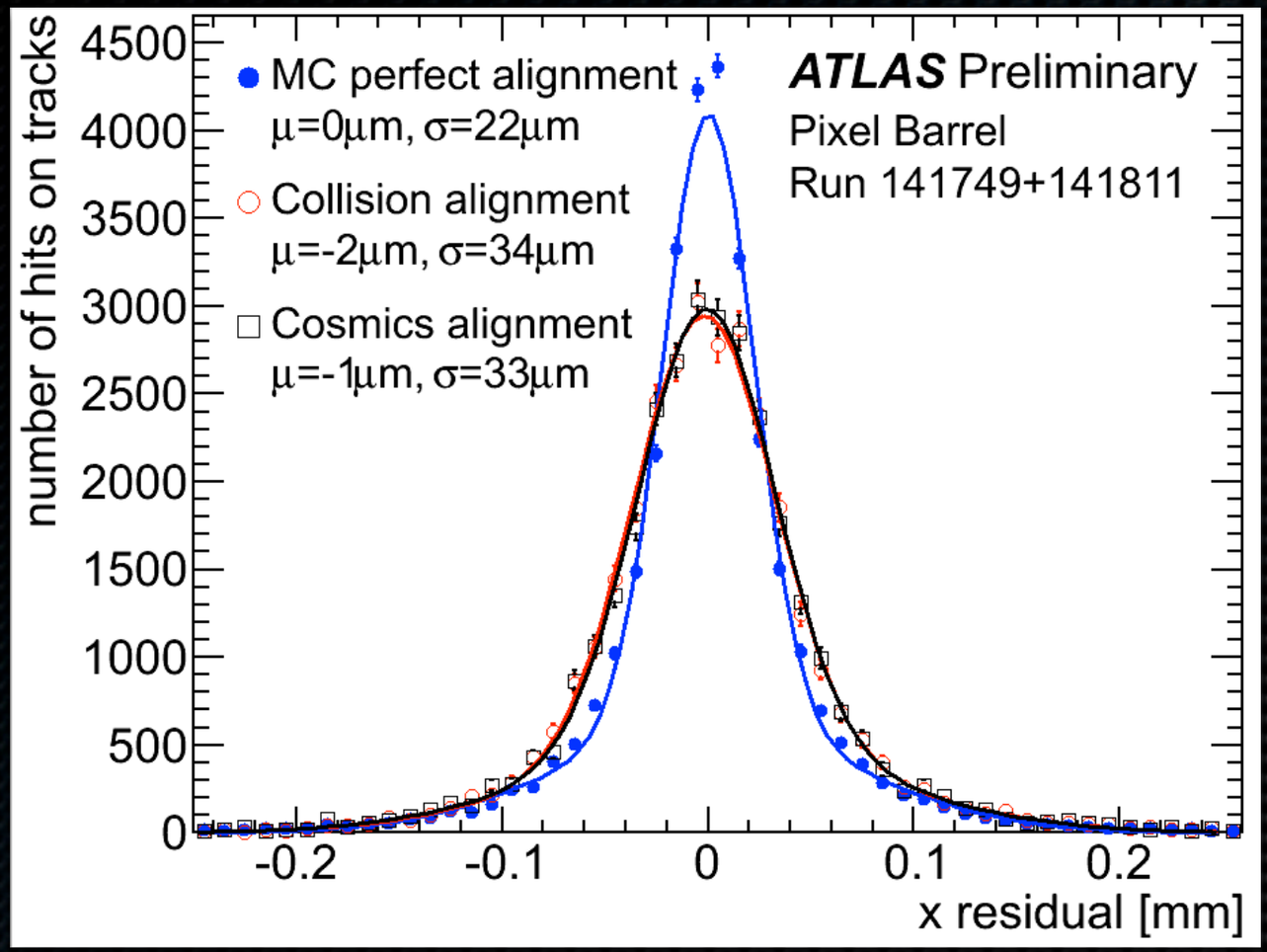


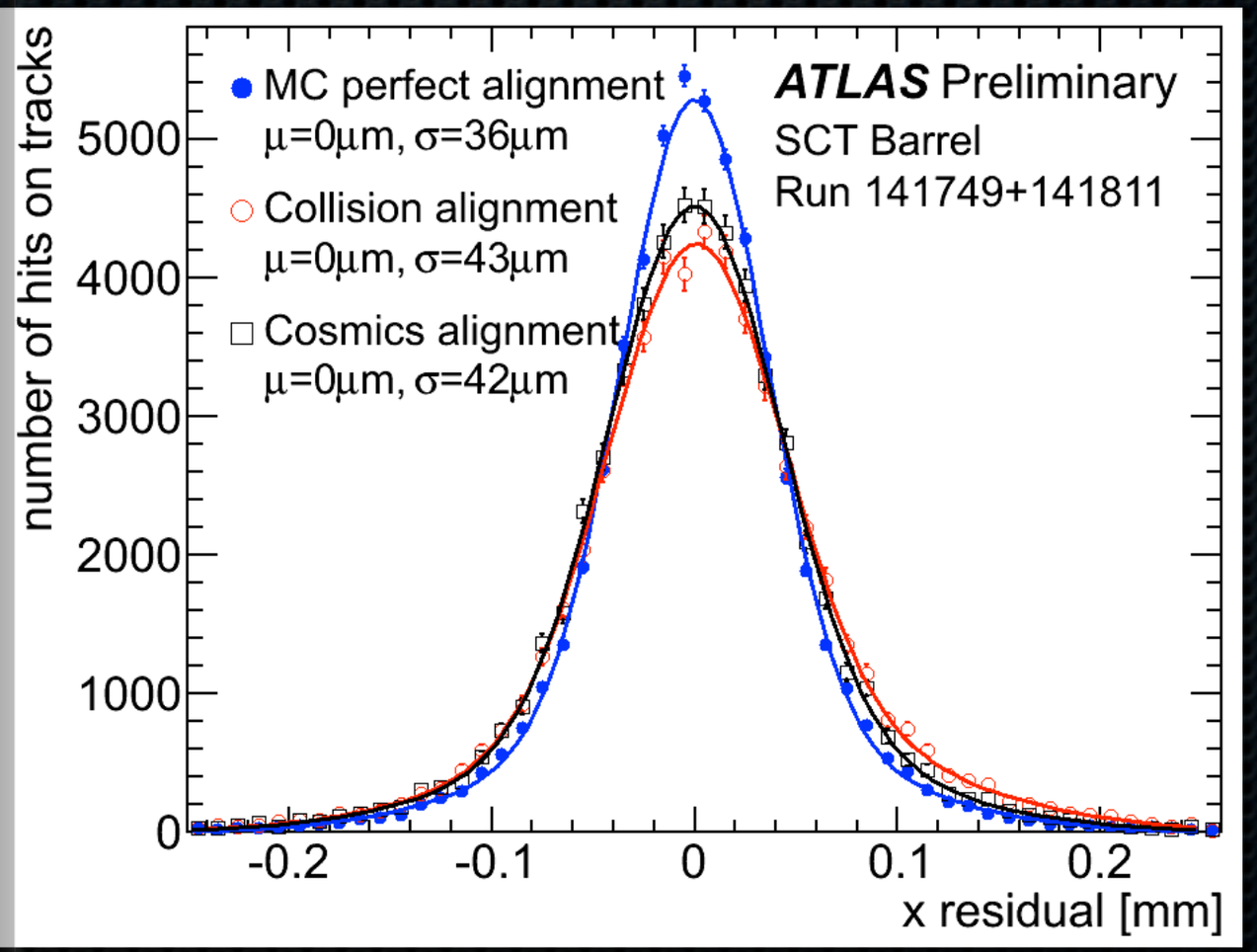
High-threshold hits in the Transition Radiation Tracker

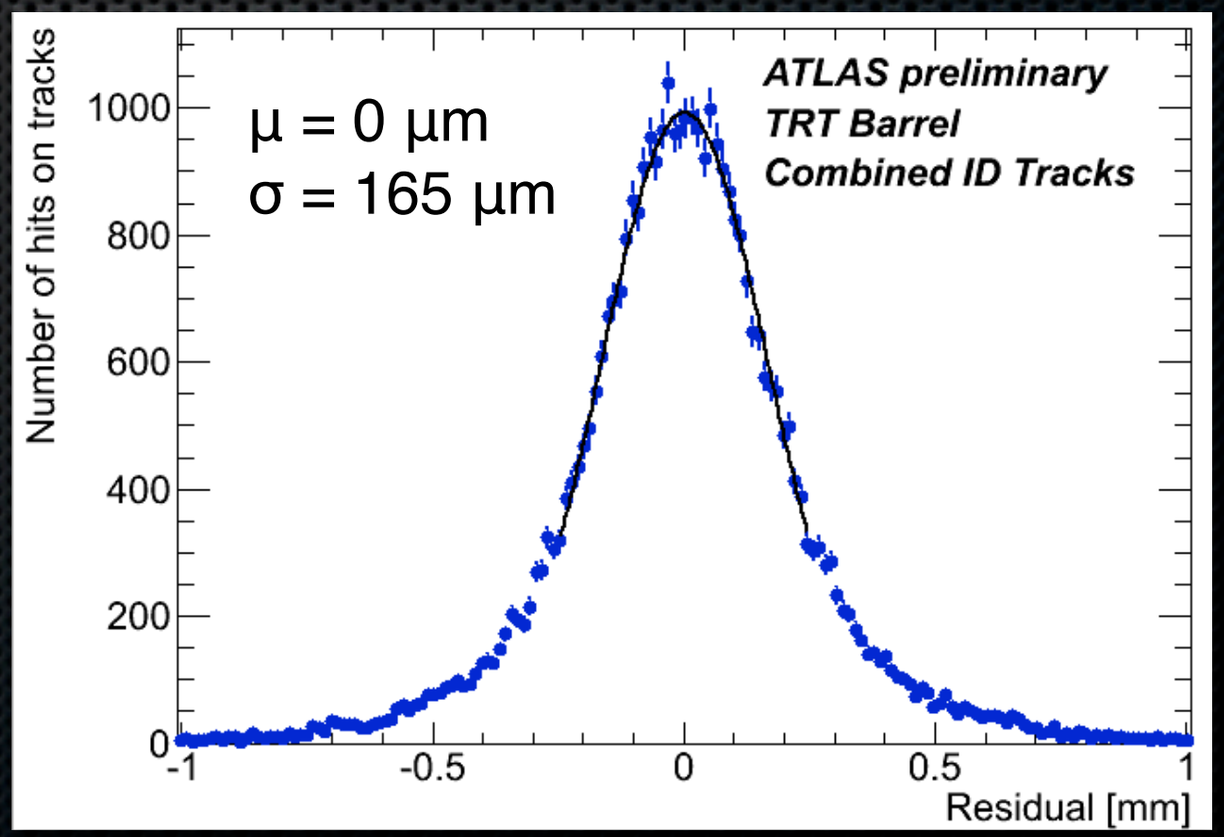


Alignment

Preliminary alignment was performed with cosmic muons, confirmed with collision events

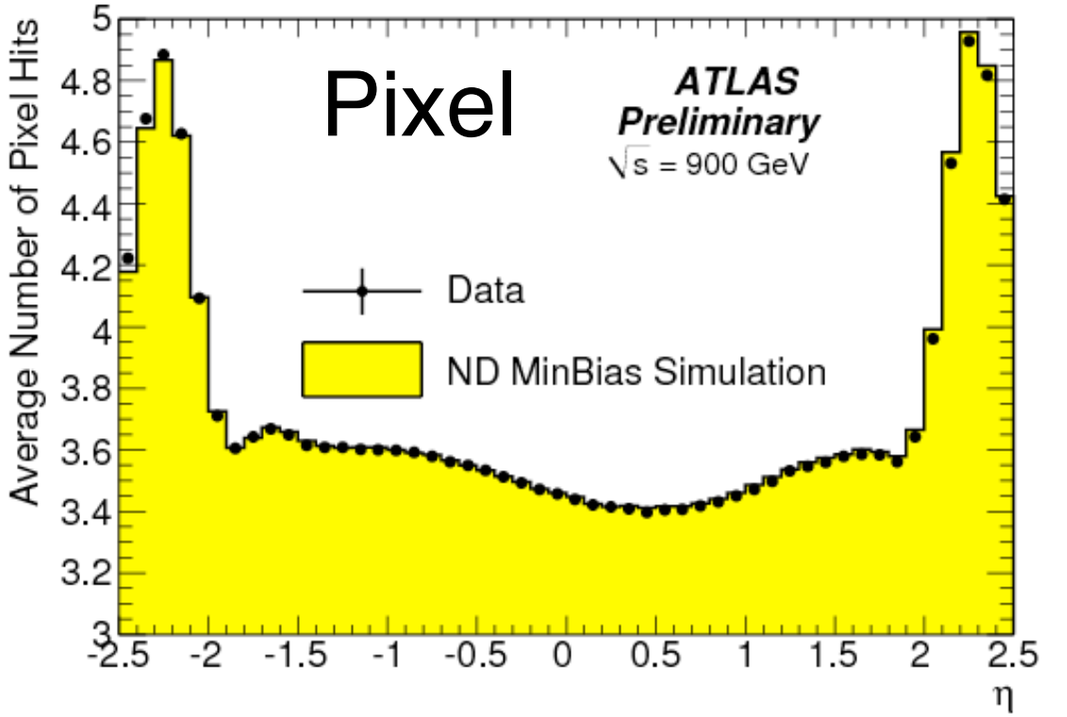


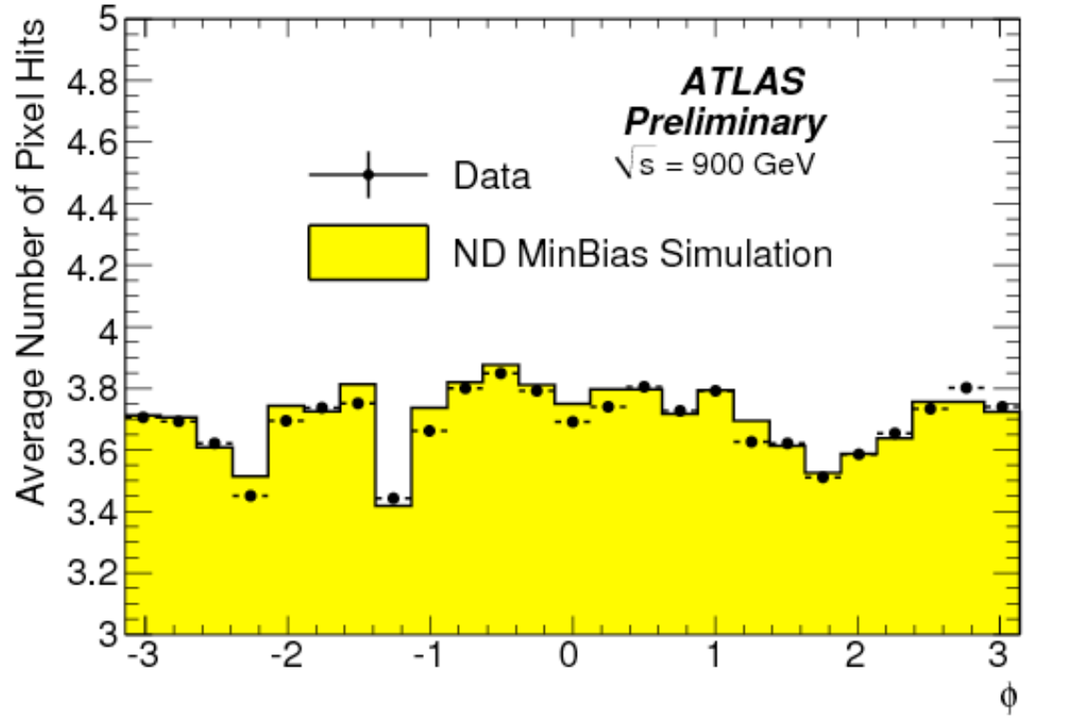


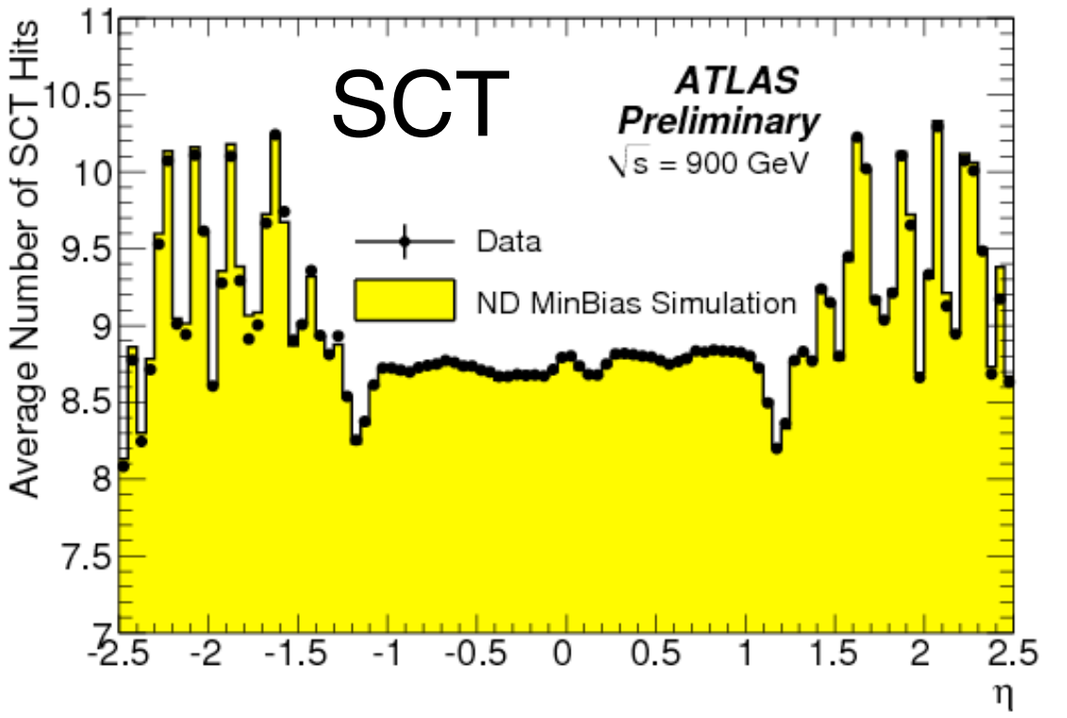


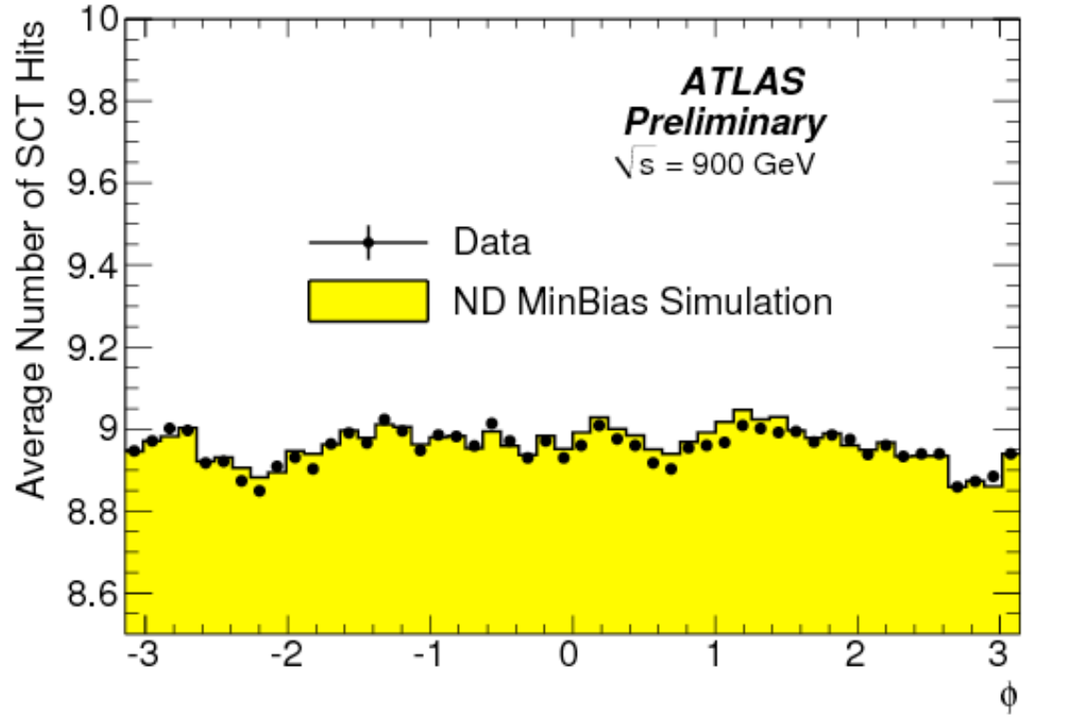
Average #Hits on Track

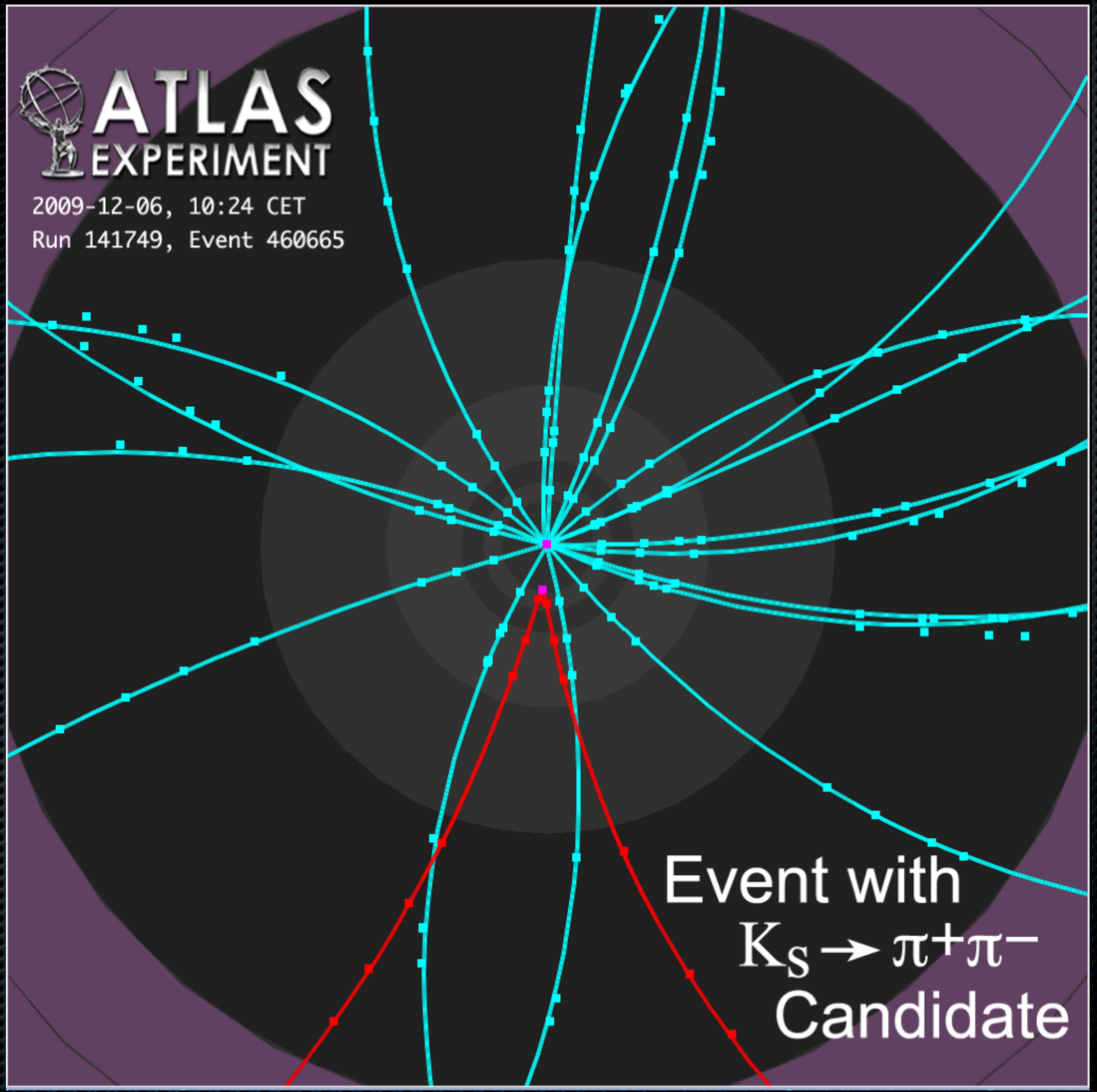
Excellent agreement w/ MC





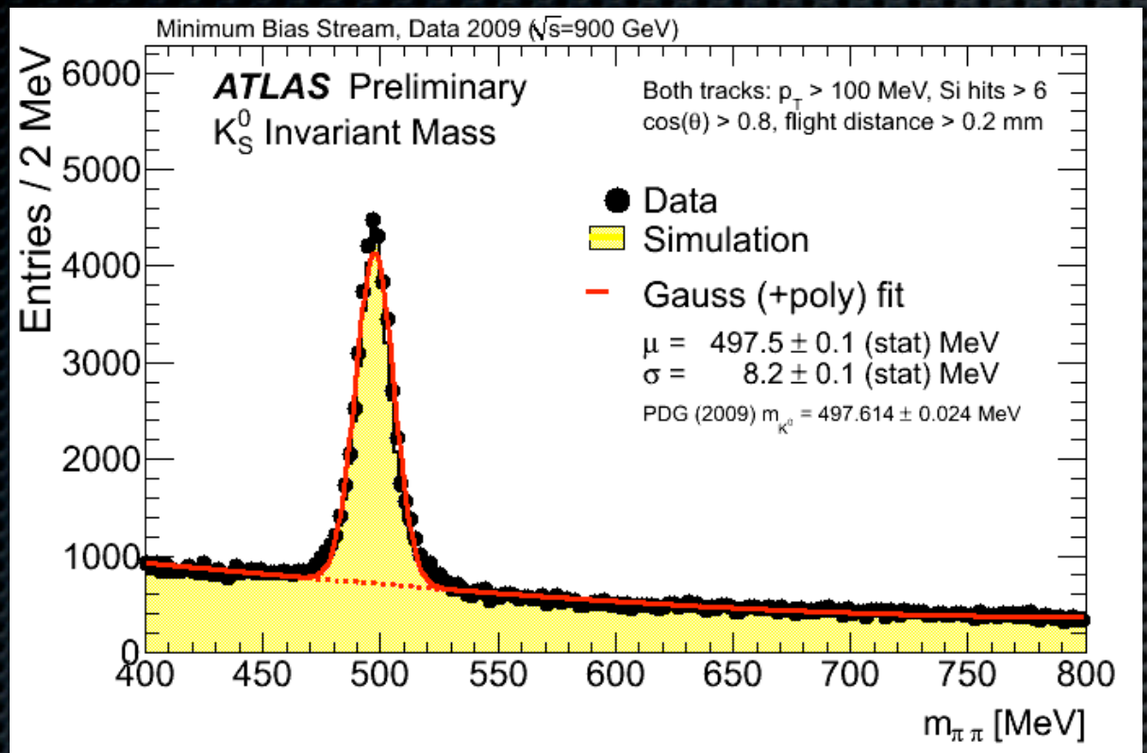


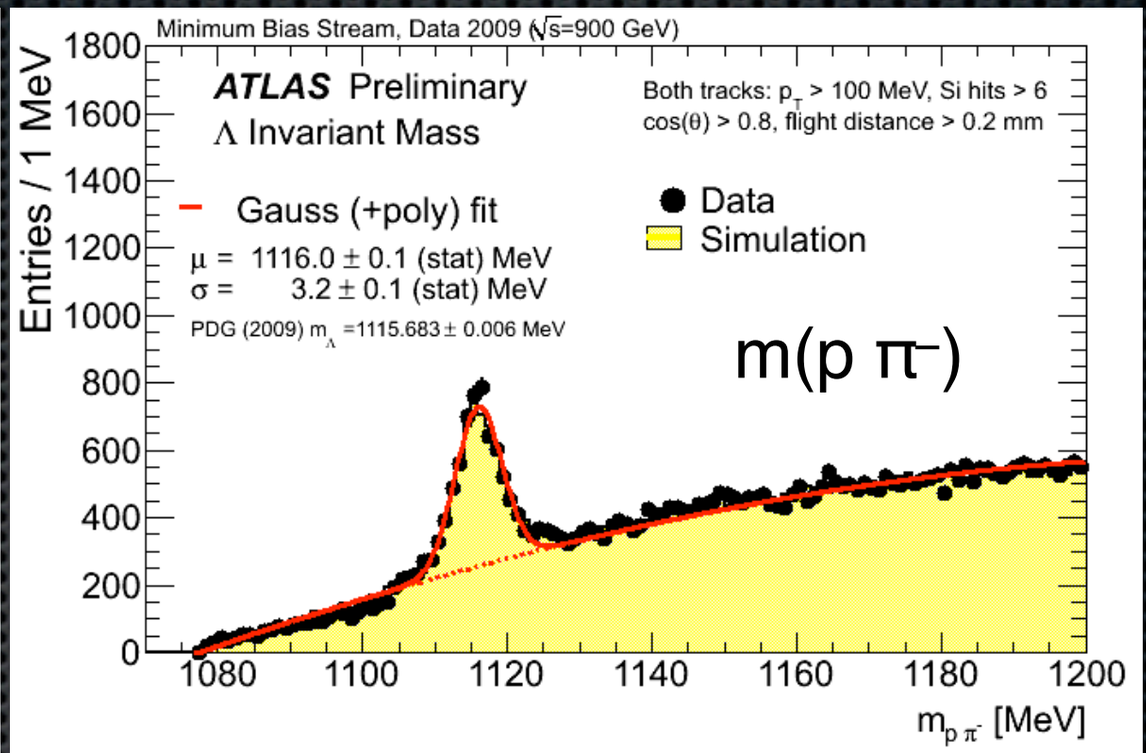


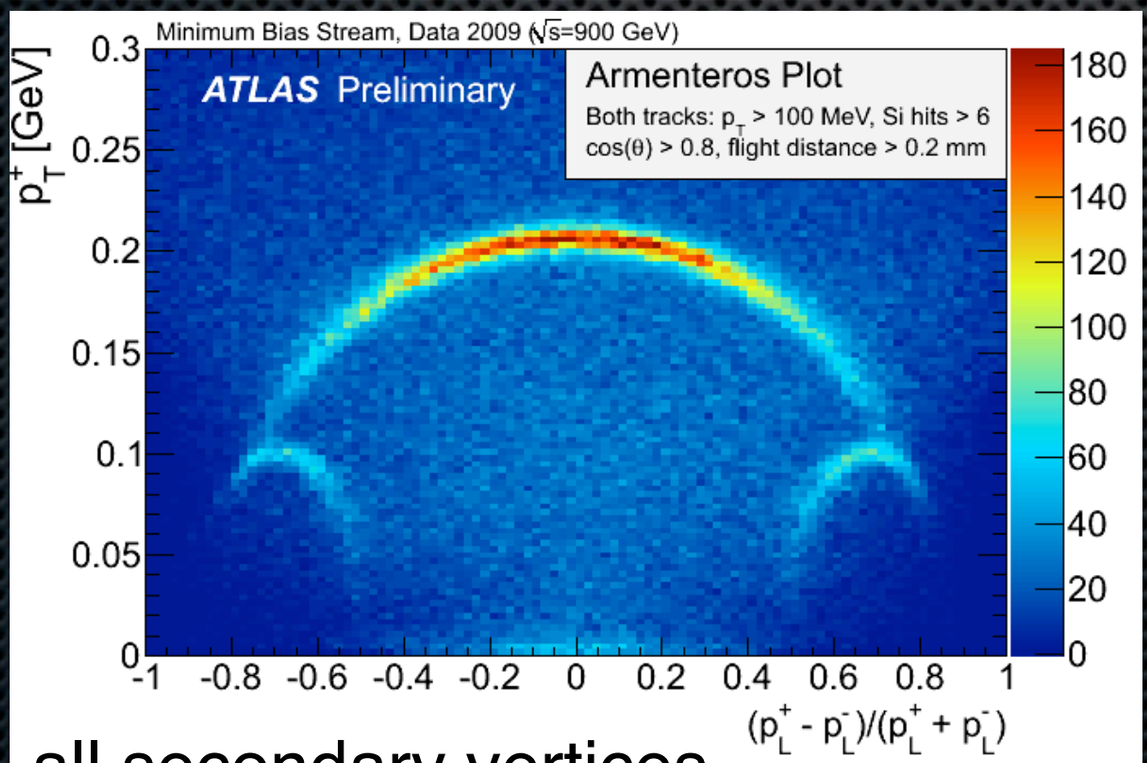

ATLAS
EXPERIMENT
2009-12-06, 10:24 CET
Run 141749, Event 460665
Event with
$K_S \rightarrow \pi^+\pi^-$
Candidate

Secondary Vertices

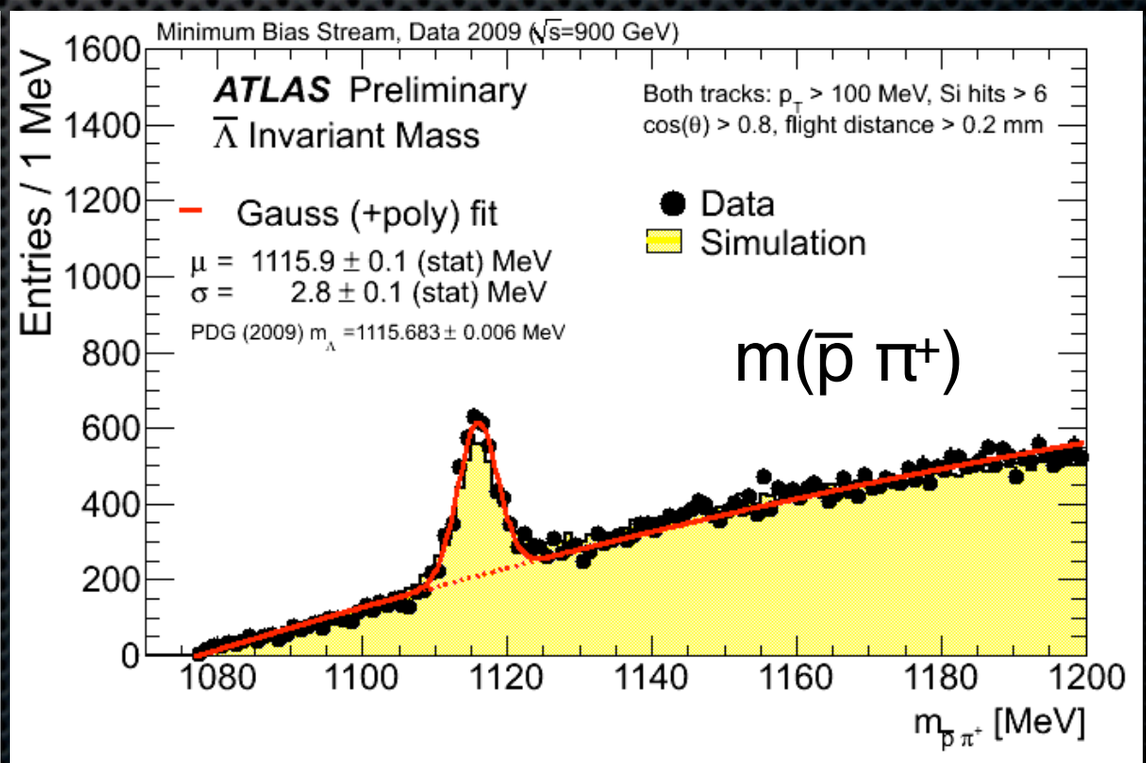
Resolutions limited by multiple scattering





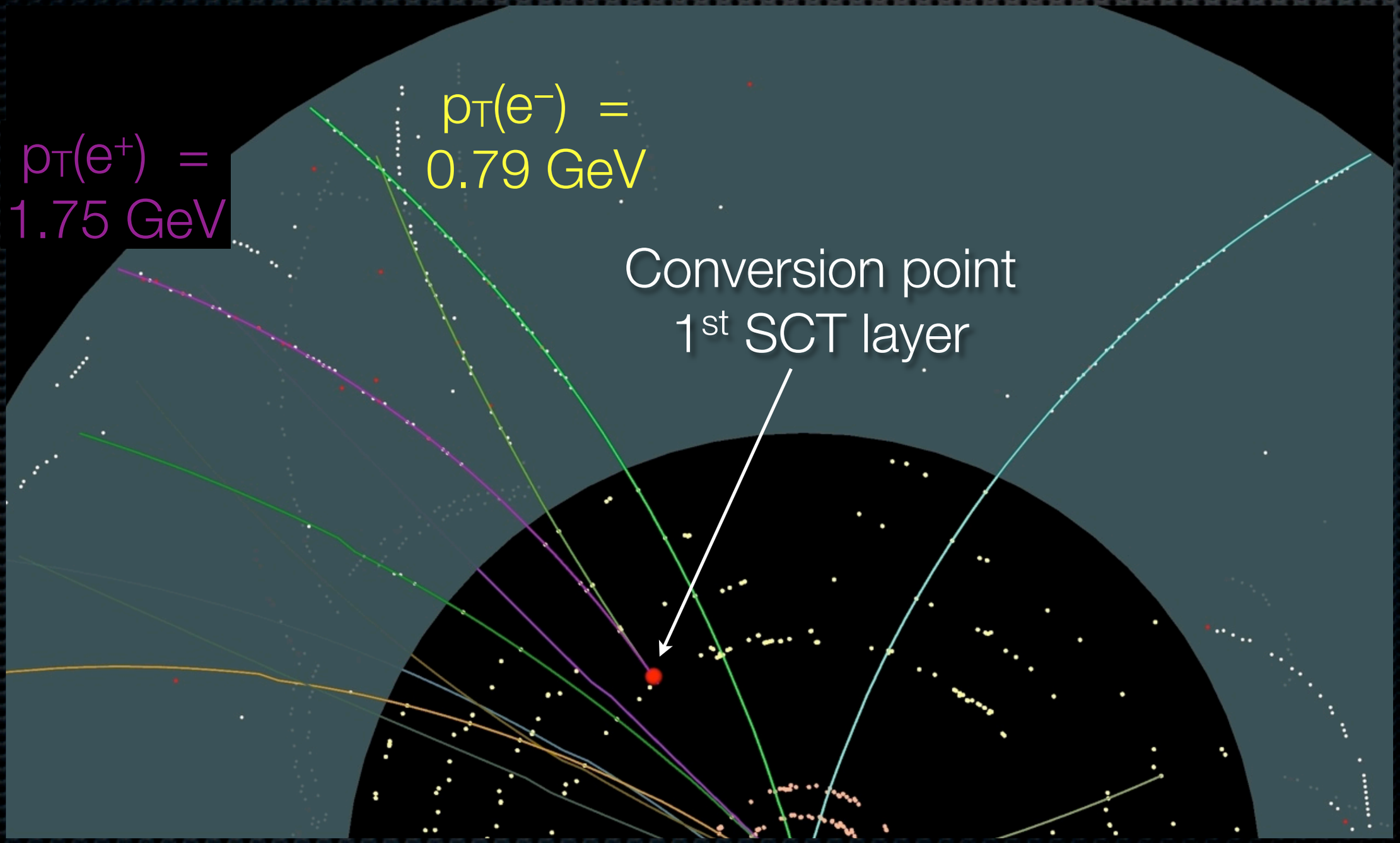


all secondary vertices

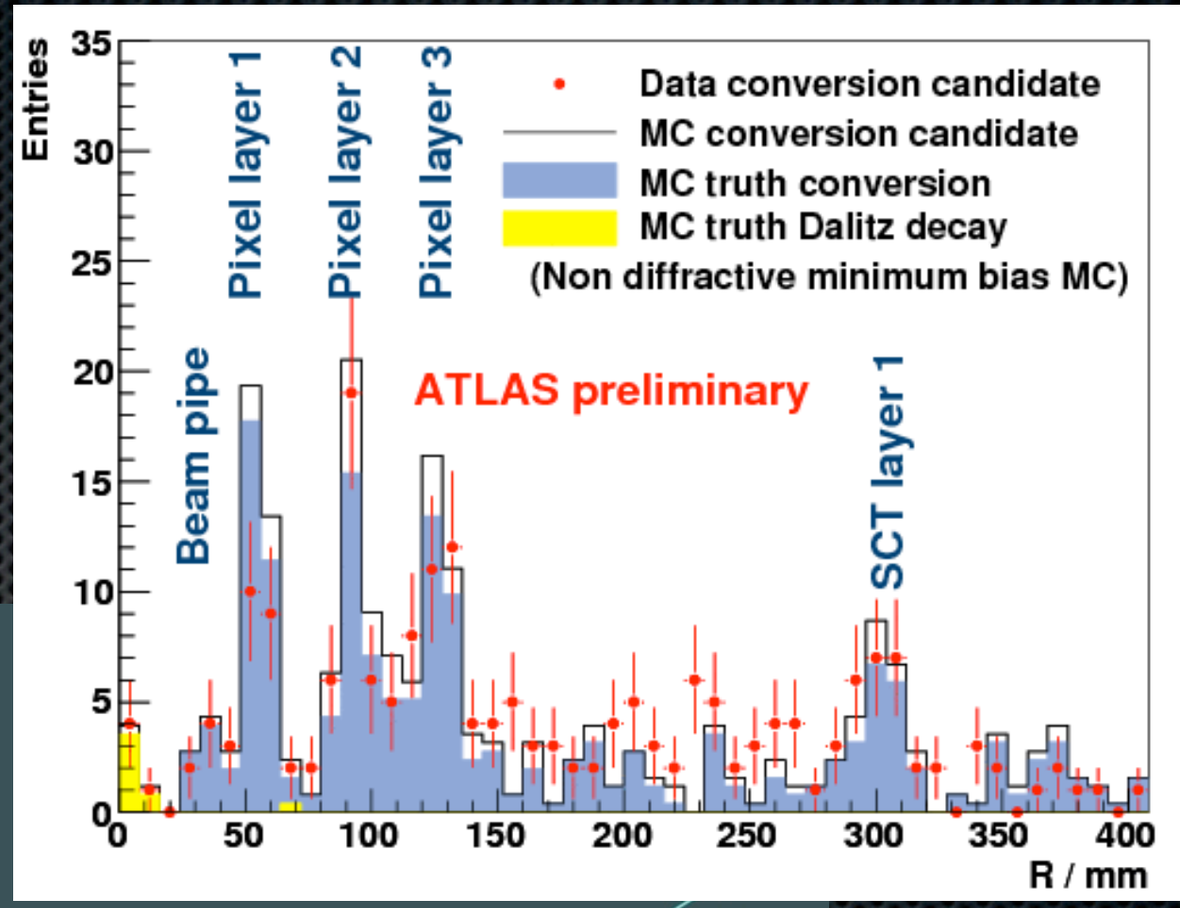


$\gamma \rightarrow e^+e^-$ Conversions

40% probability at $\eta = 0$



$\gamma \rightarrow e^+e^-$ Conversions

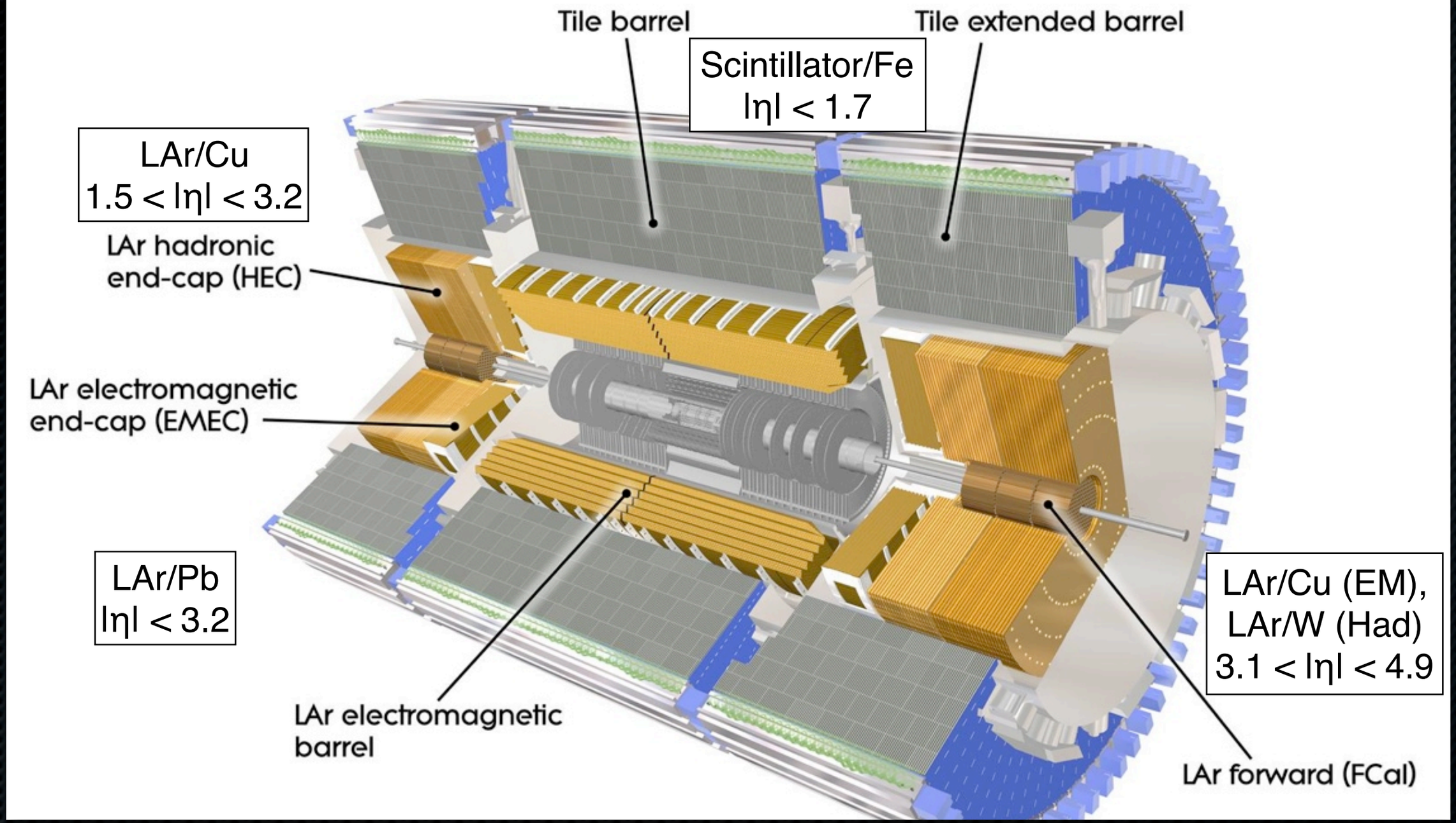


$p_T(e^+)$ = 1.75 GeV

$p_T(e^-)$ = 0.79 GeV

Conversion point 1st SCT layer

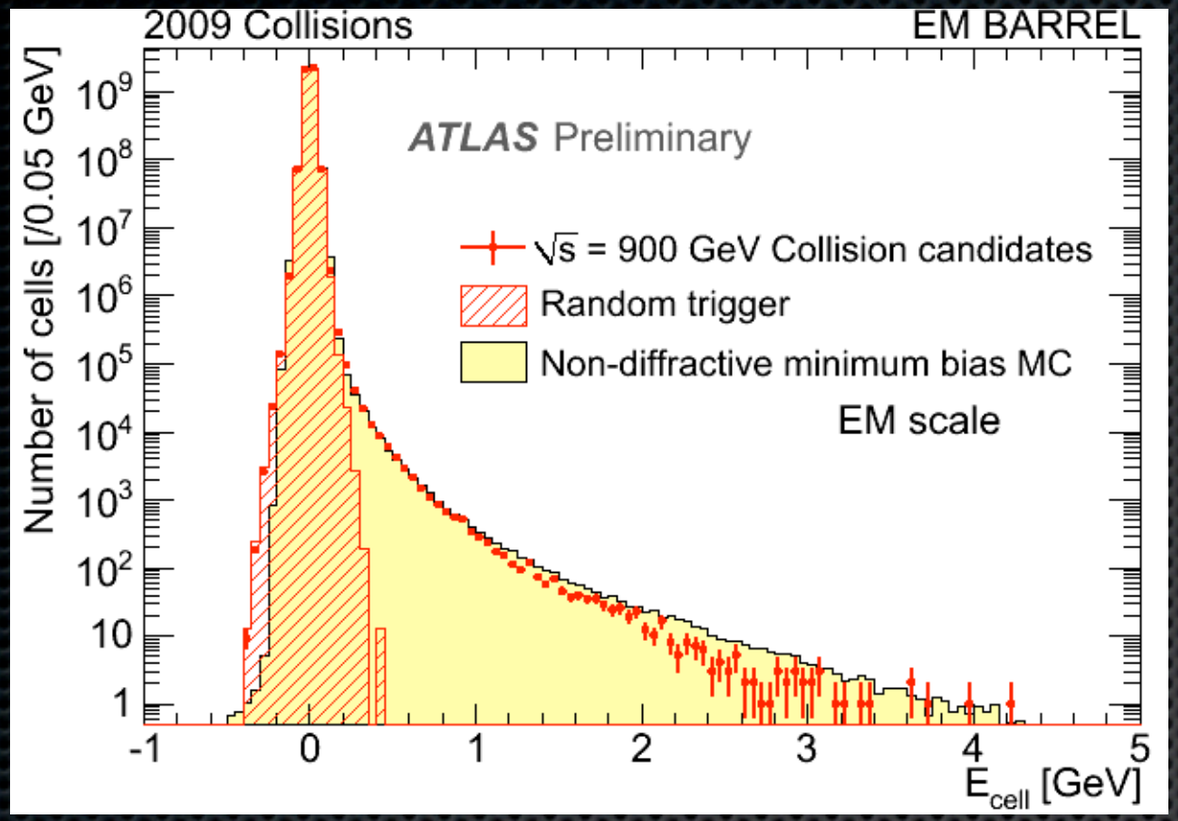
Conversions map the material in front of the calorimeters

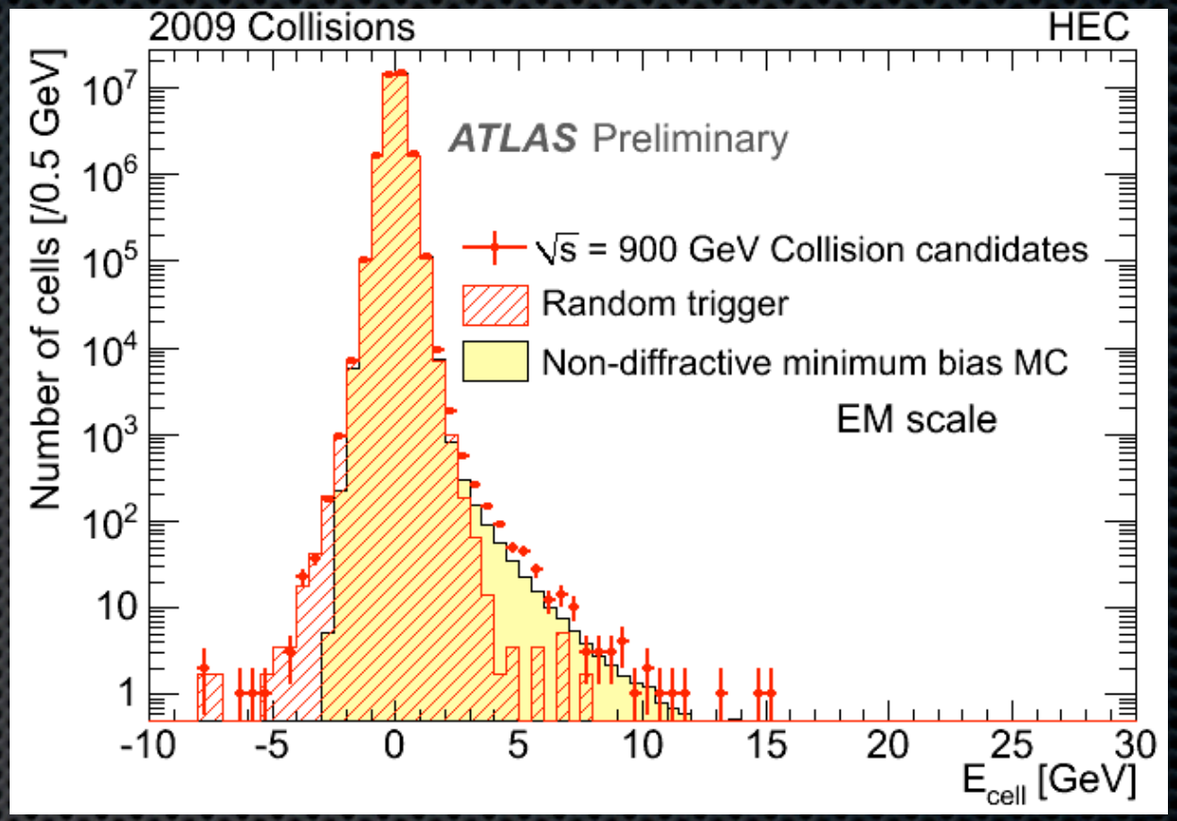


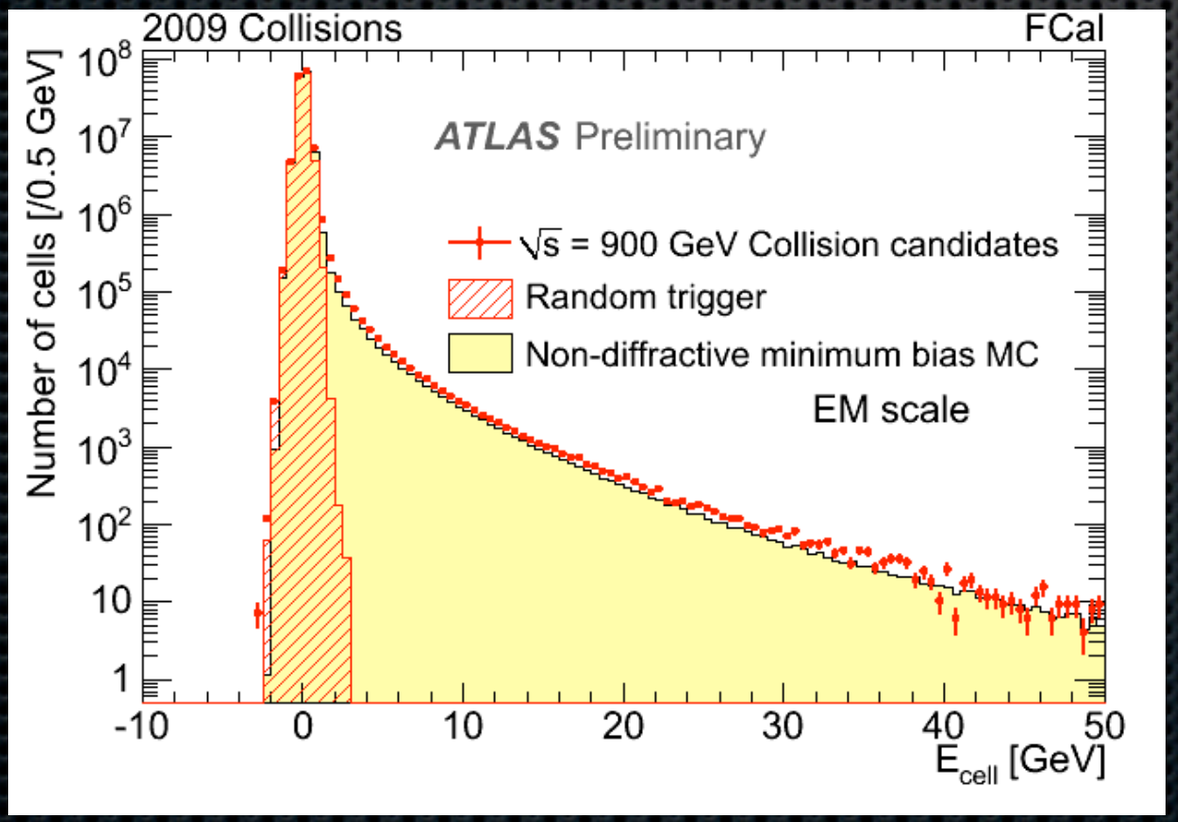
Calorimeters

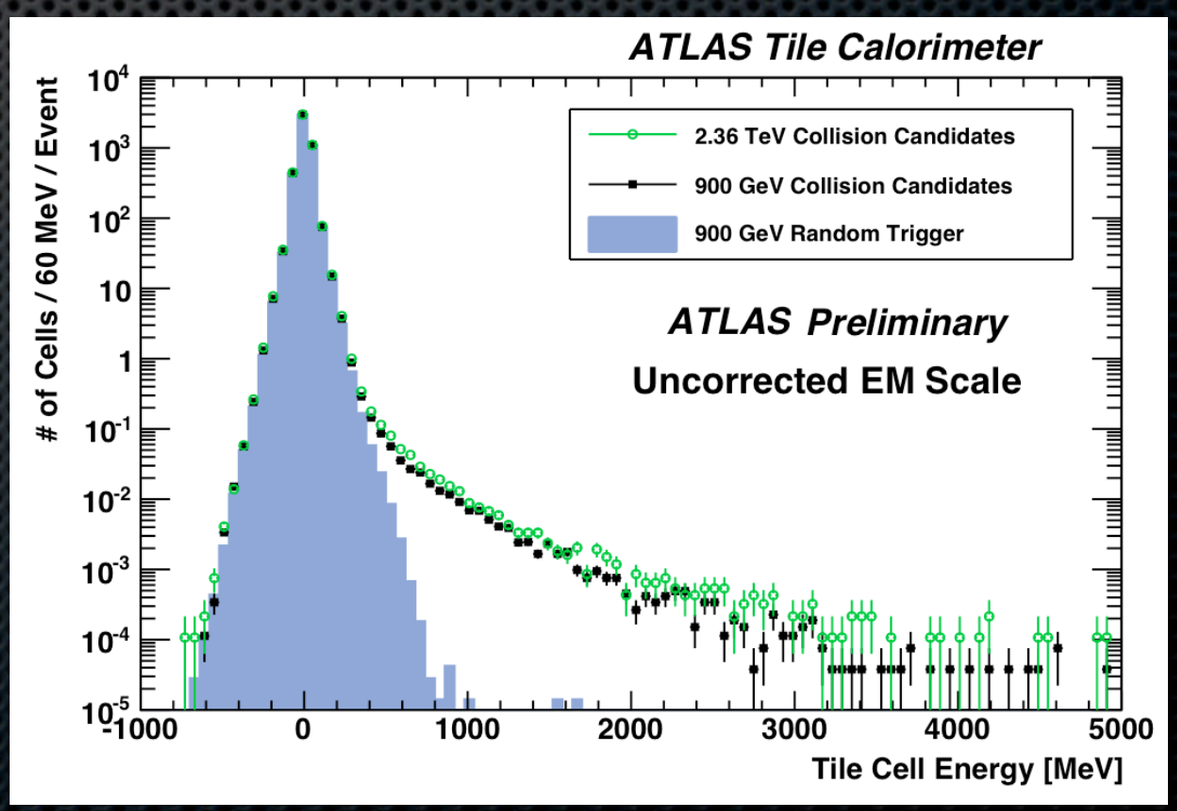
Electromagnetic and Hadronic

Cell Energy Distributions



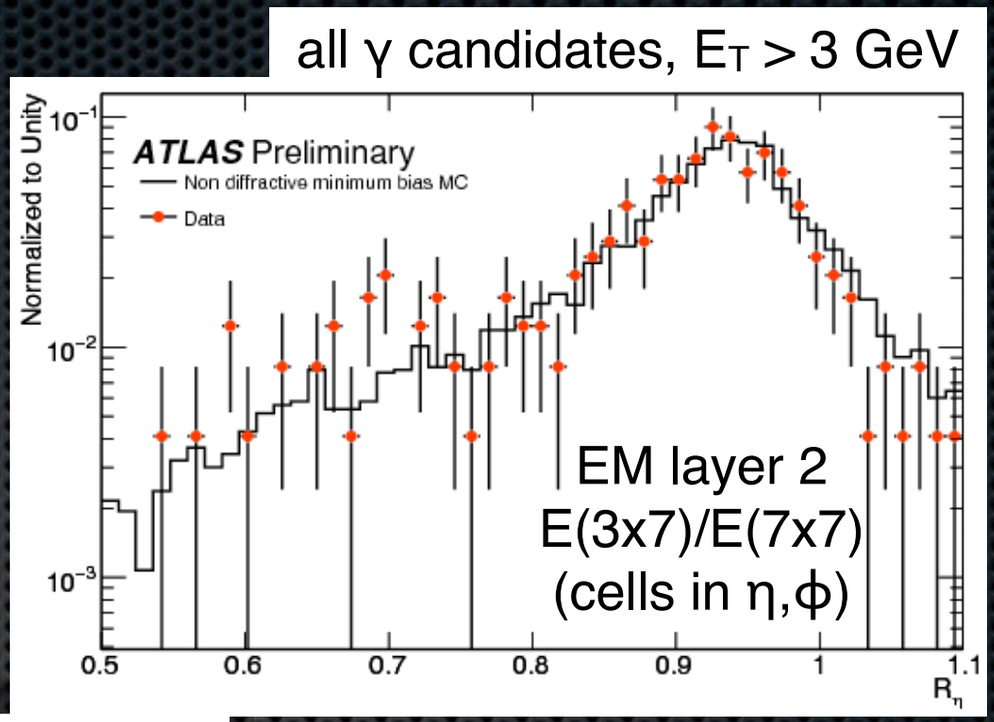


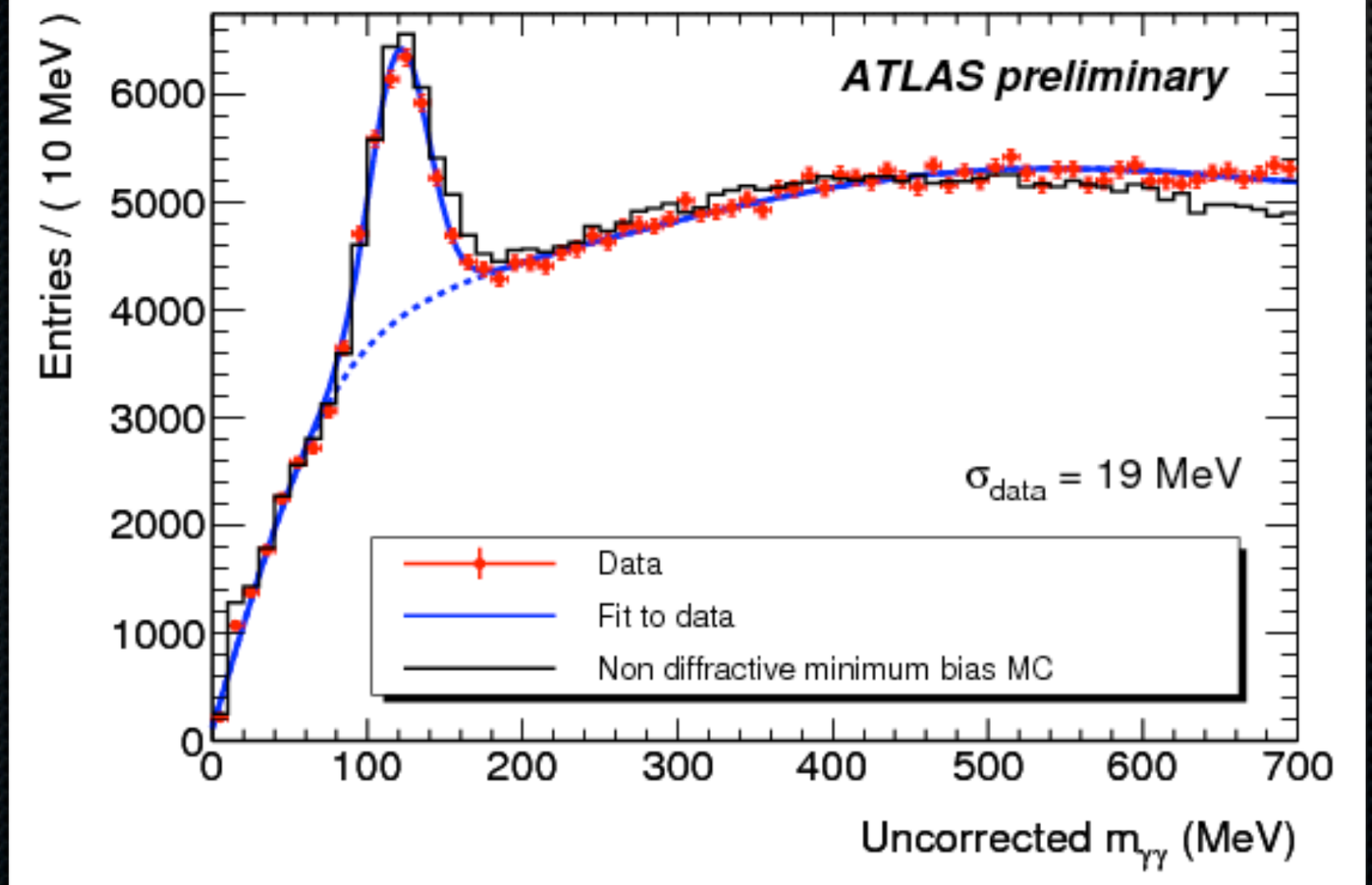




$\pi^0 \rightarrow \gamma\gamma$

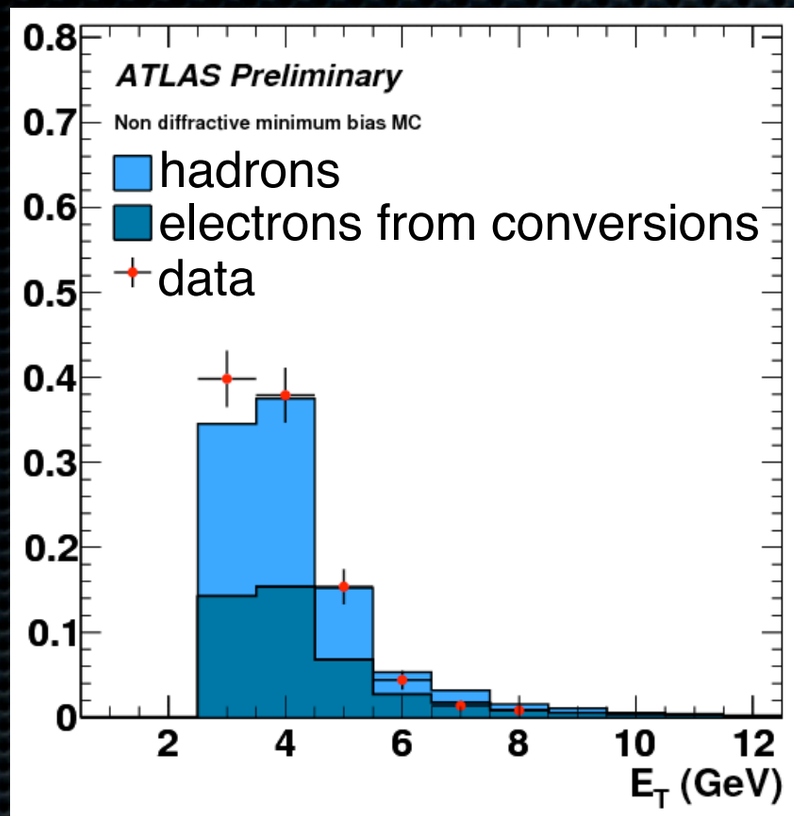
2 γ candidates w/ $E_T(\gamma) > 300$ MeV;
$E_T(\gamma\gamma) > 900$ MeV

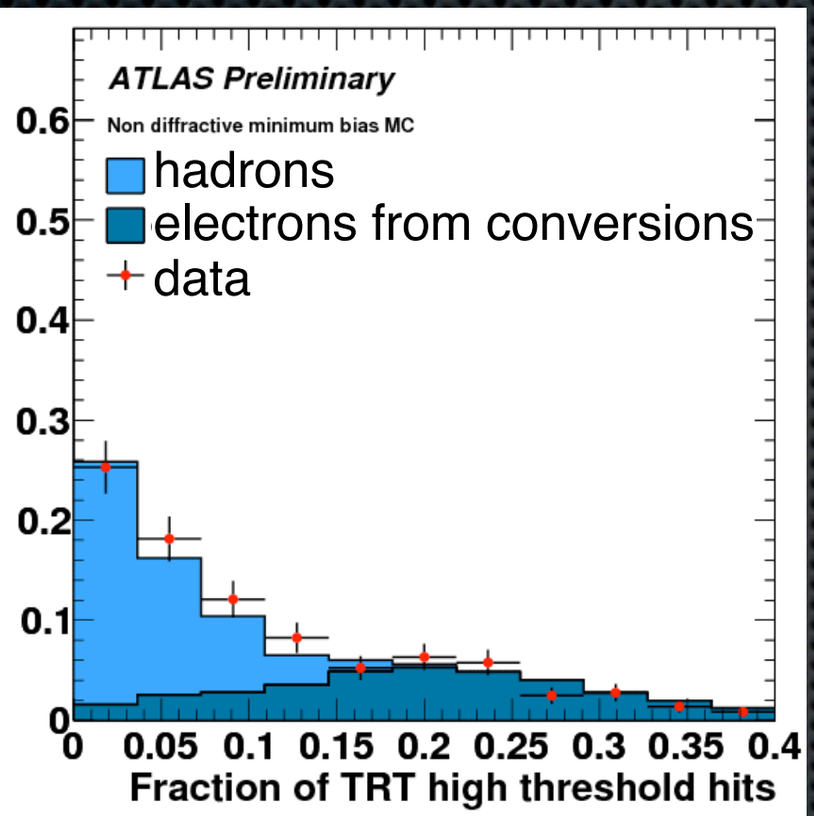


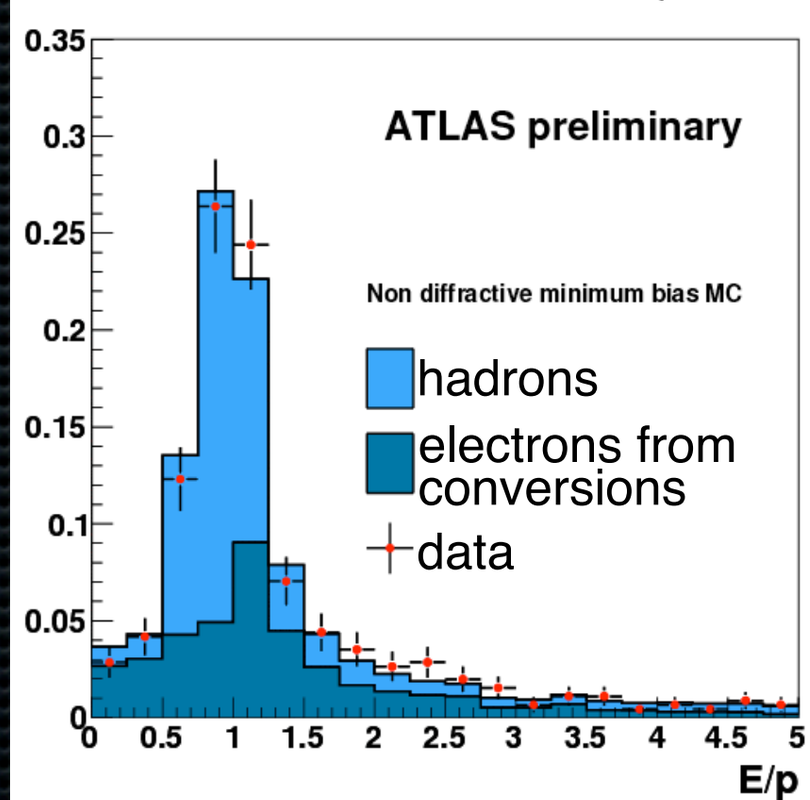


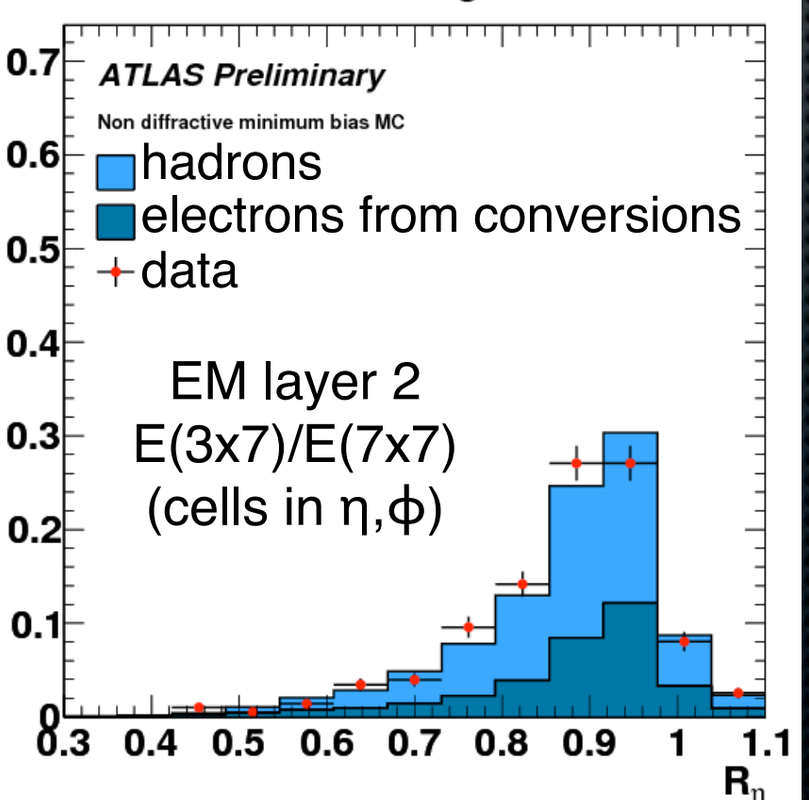
- shower shapes compatible with photons
- no corrections for upstream material
- data/MC normalized to same area

Electron Identification





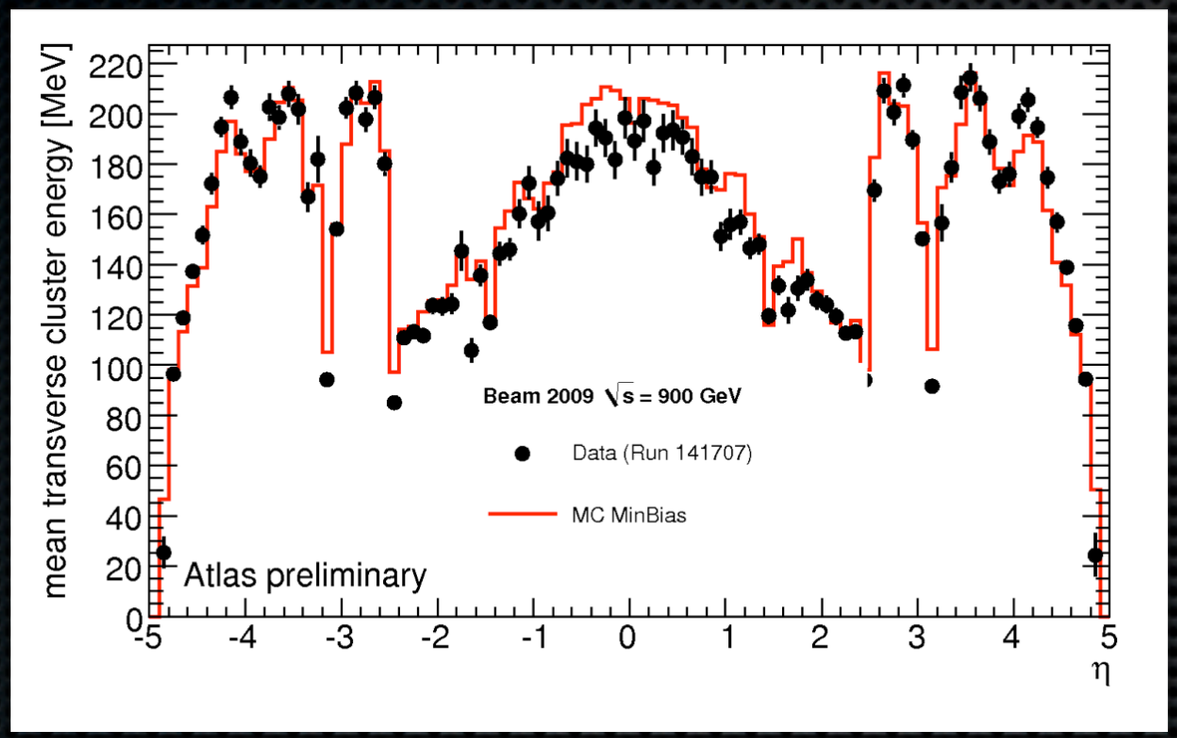


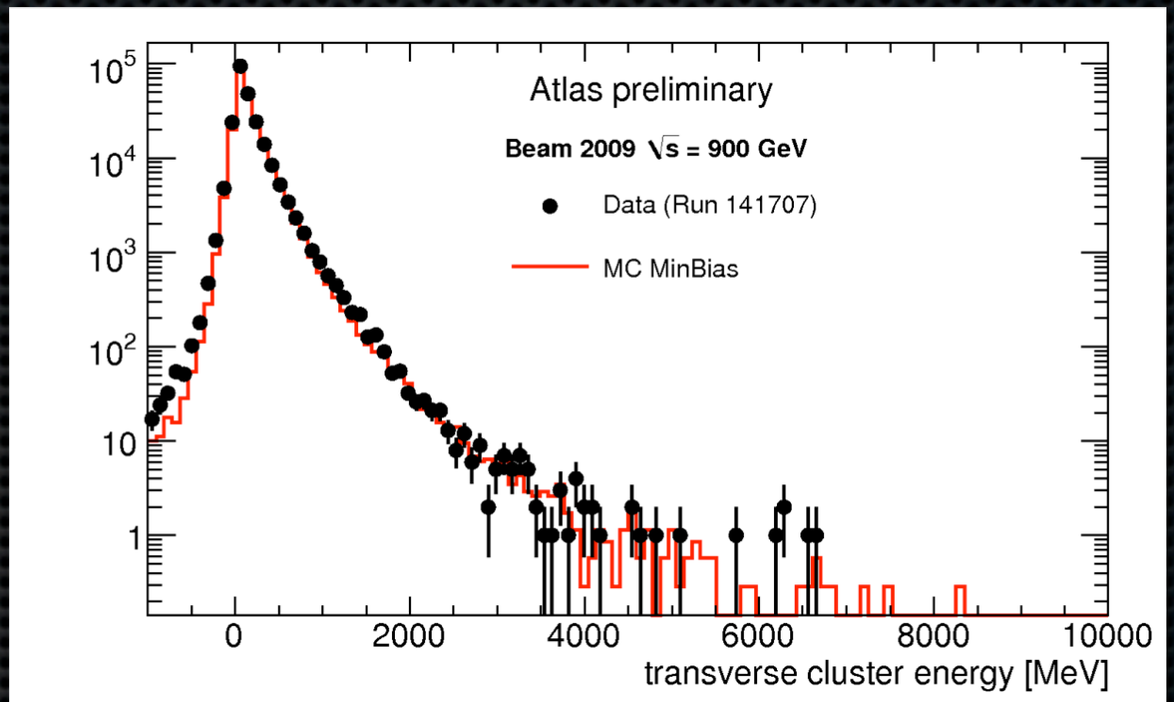


- expected background: 70% hadrons, 30% from conversions
- sliding window EM cluster ($E_T > 2.5$ GeV)
- loosely matched to a reconstructed track ($p_T > 0.5$ GeV)
- 783 electron candidates; 364 fulfill loose shower shape criteria

Calorimeter Clusters

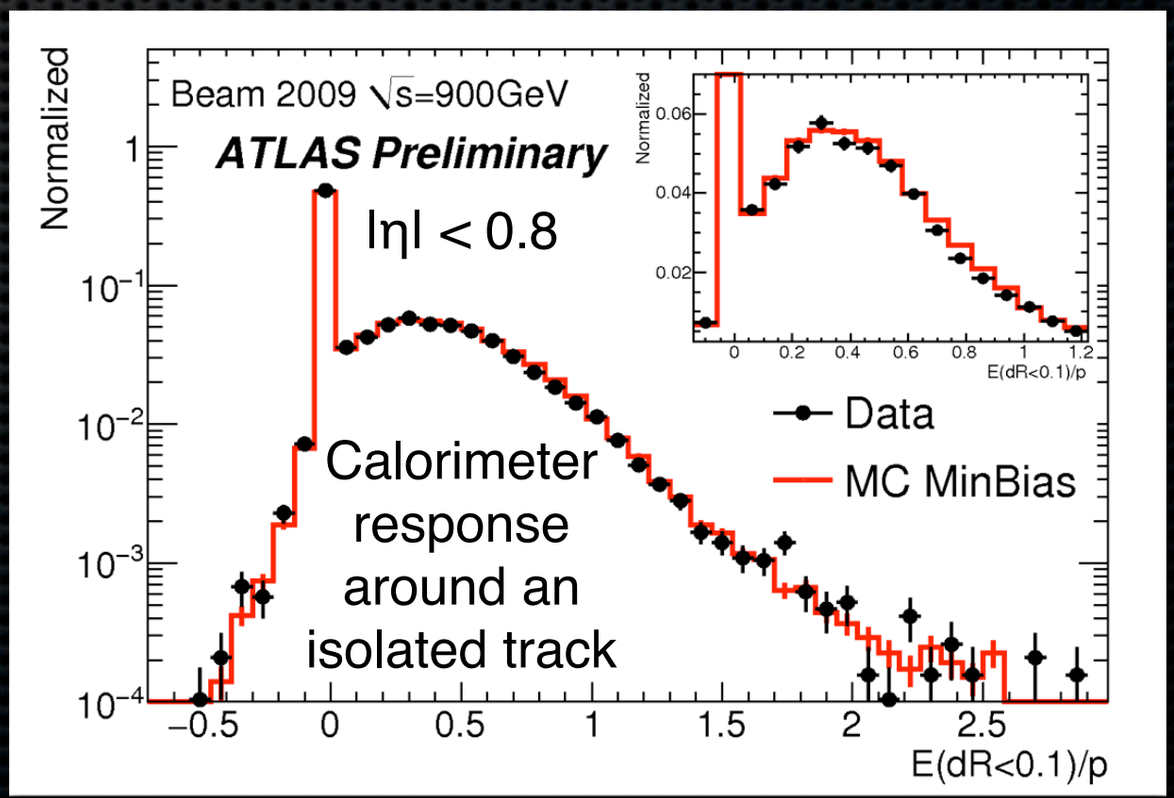
3-D topological clusters are formed with a 4/2/0σ noise suppression algorithm

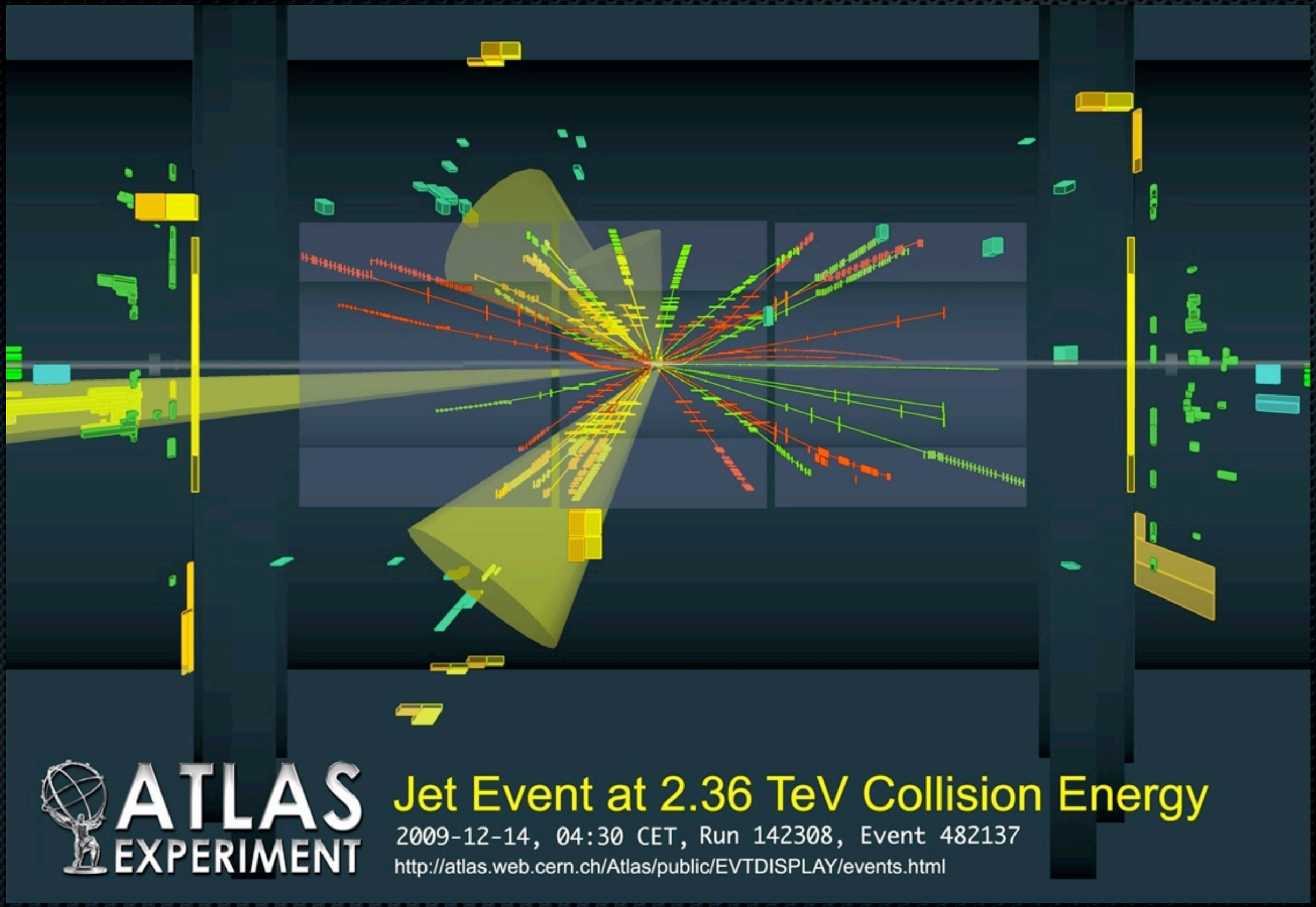




starting point for jet reconstruction

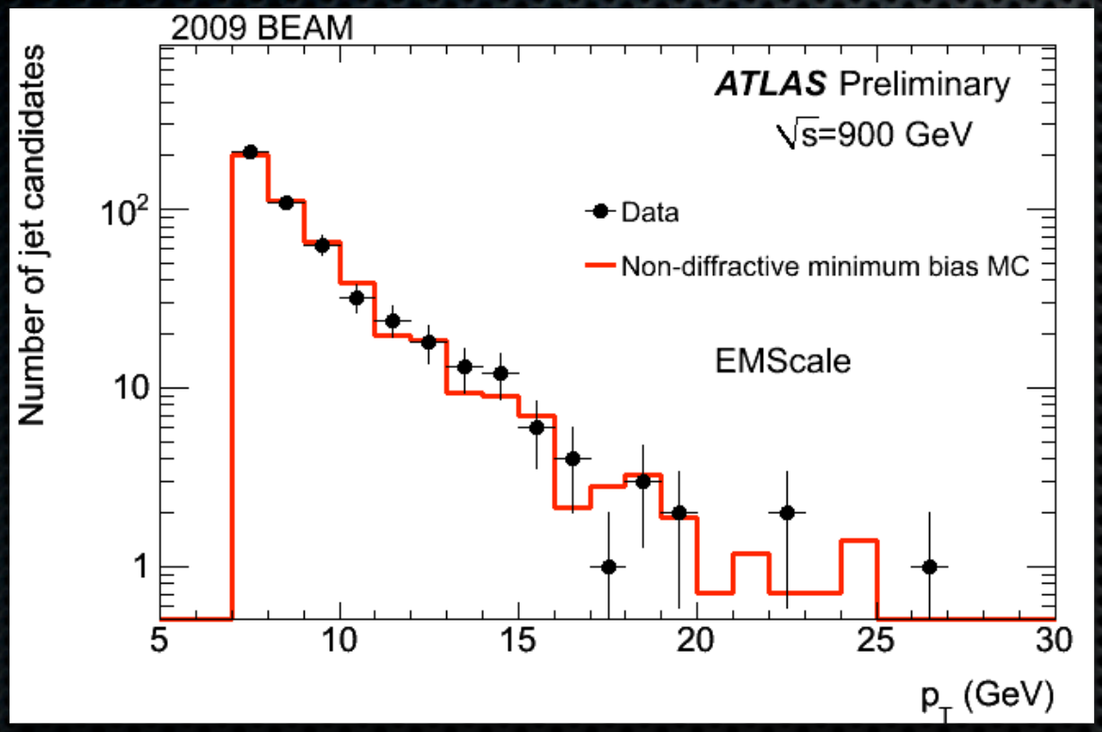
energy can be computed at EM scale or can apply refined calibration

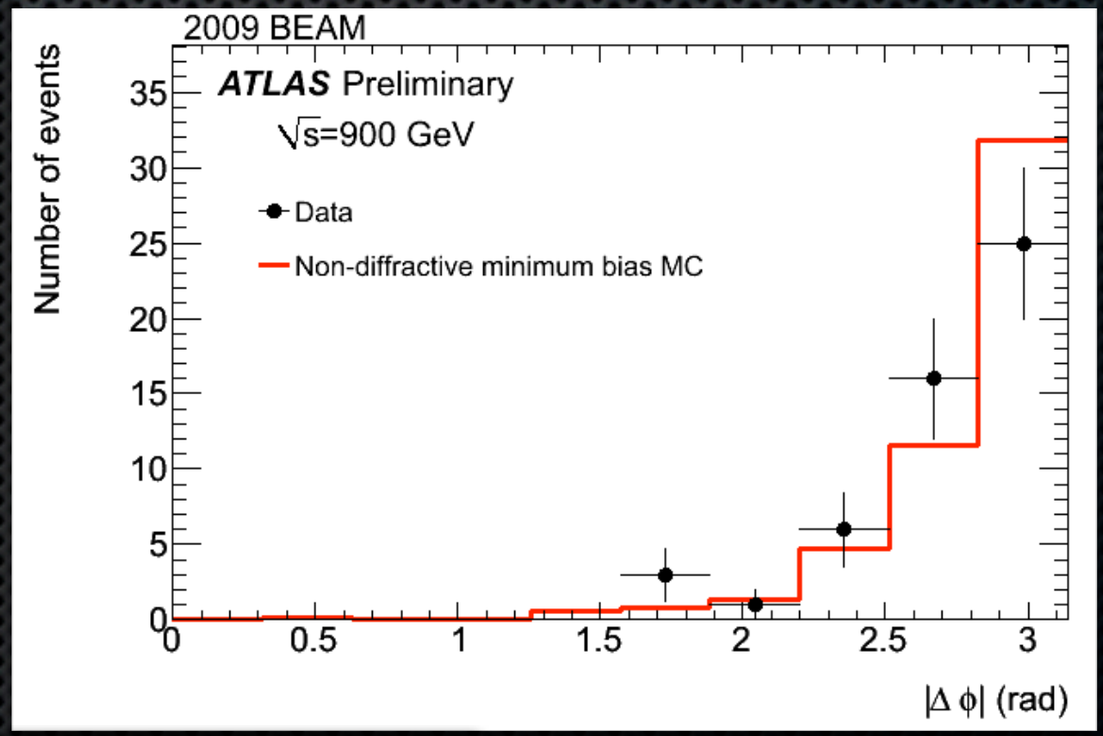


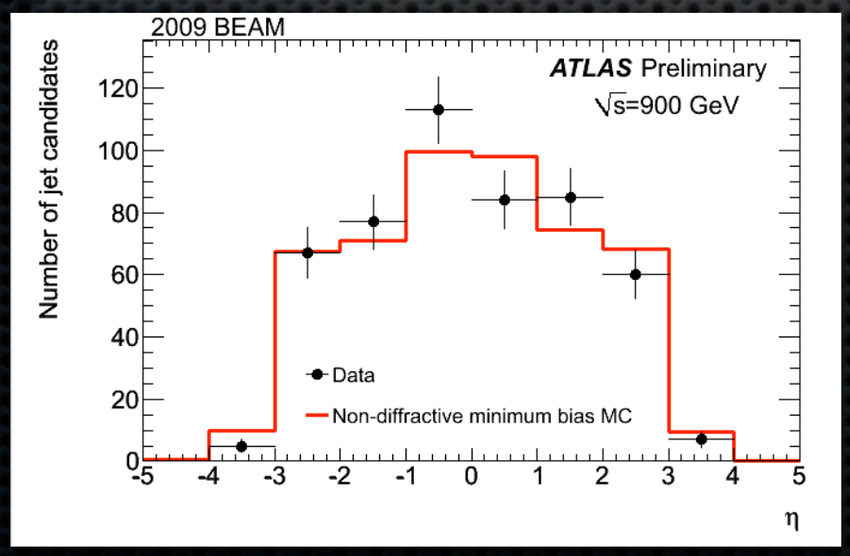

ATLAS
EXPERIMENT
Jet Event at 2.36 TeV Collision Energy
2009-12-14, 04:30 CET, Run 142308, Event 482137
http://atlas.web.cern.ch/Atlas/public/EVTDISPLAY/events.html

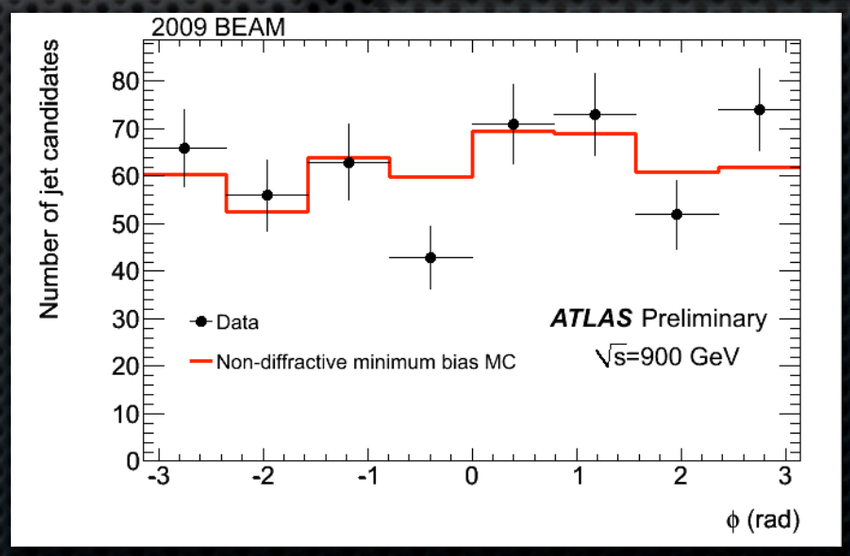
Jet Performance

Anti-k_T algorithm with d = 0.4;
constituents are 3-D topological clusters





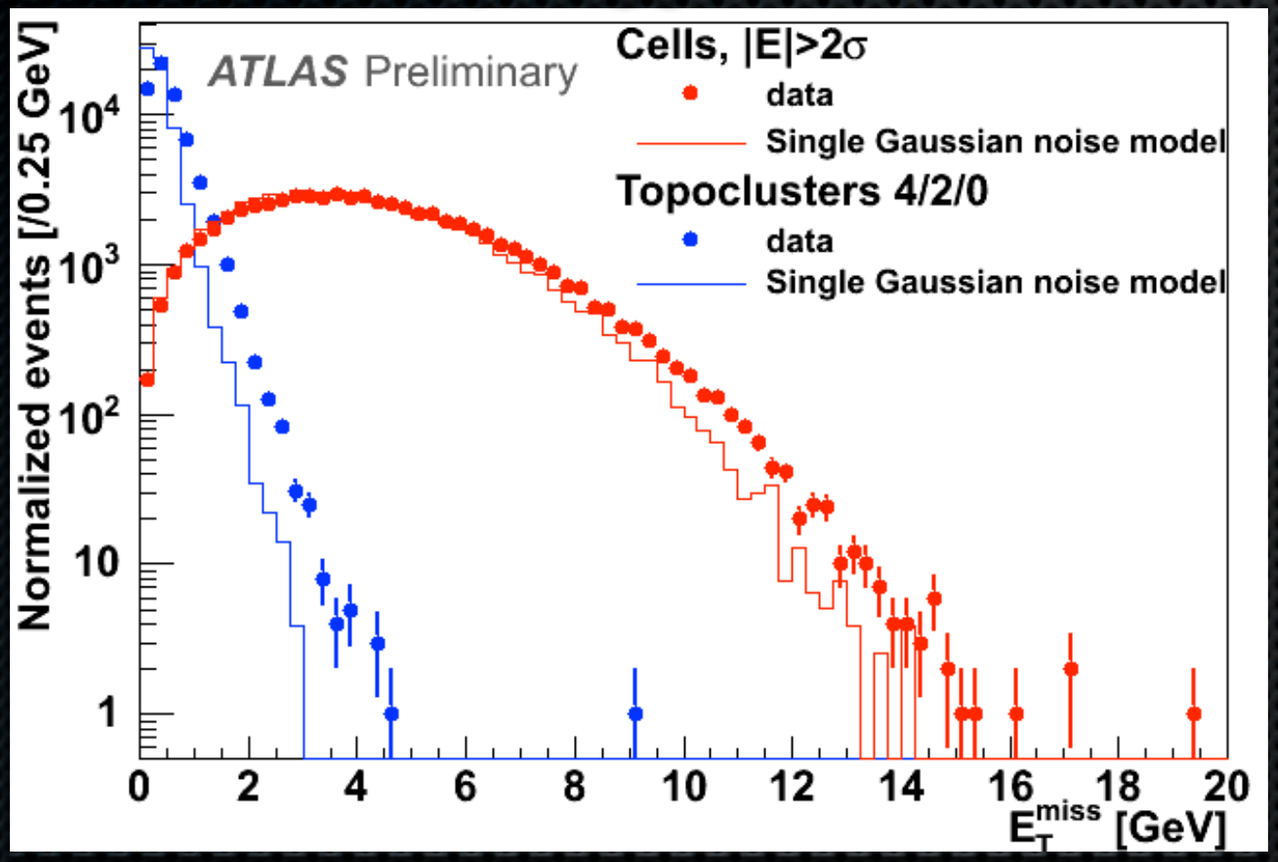




EM Scale;
no calibrations applied

Missing Transverse Energy

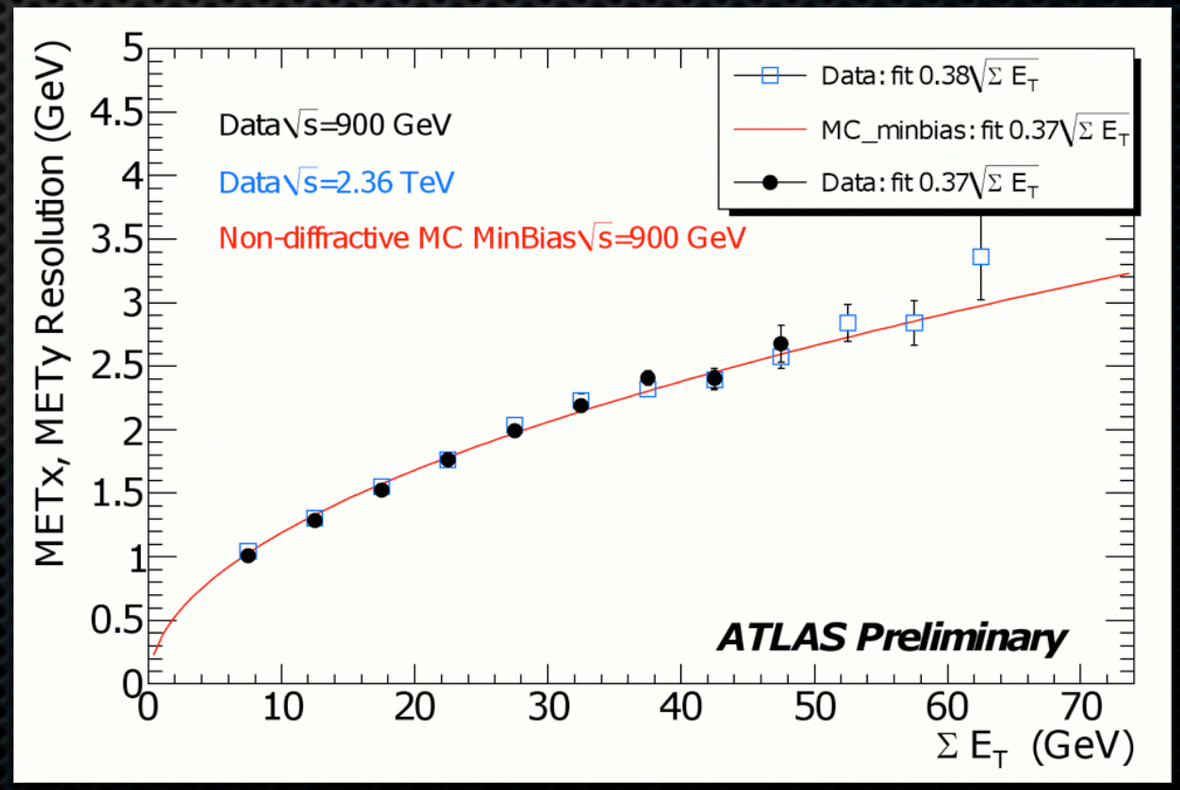
randomly triggered events



EM Scale;
no calibrations applied

measured over full calorimeter coverage
(2π in ϕ, |η| < 5, ~200k cells)

resolution



Summary and Outlook

- 2009 brought the first LHC collision data
- ATLAS was **ready** and successfully recorded ~20μb^{-1}
- The first indications are that the detector is performing well... years of detailed simulations, test-beam activities and cosmics commissioning are paying off
- The collaboration looks eagerly toward more data very soon! at high energy and high luminosity

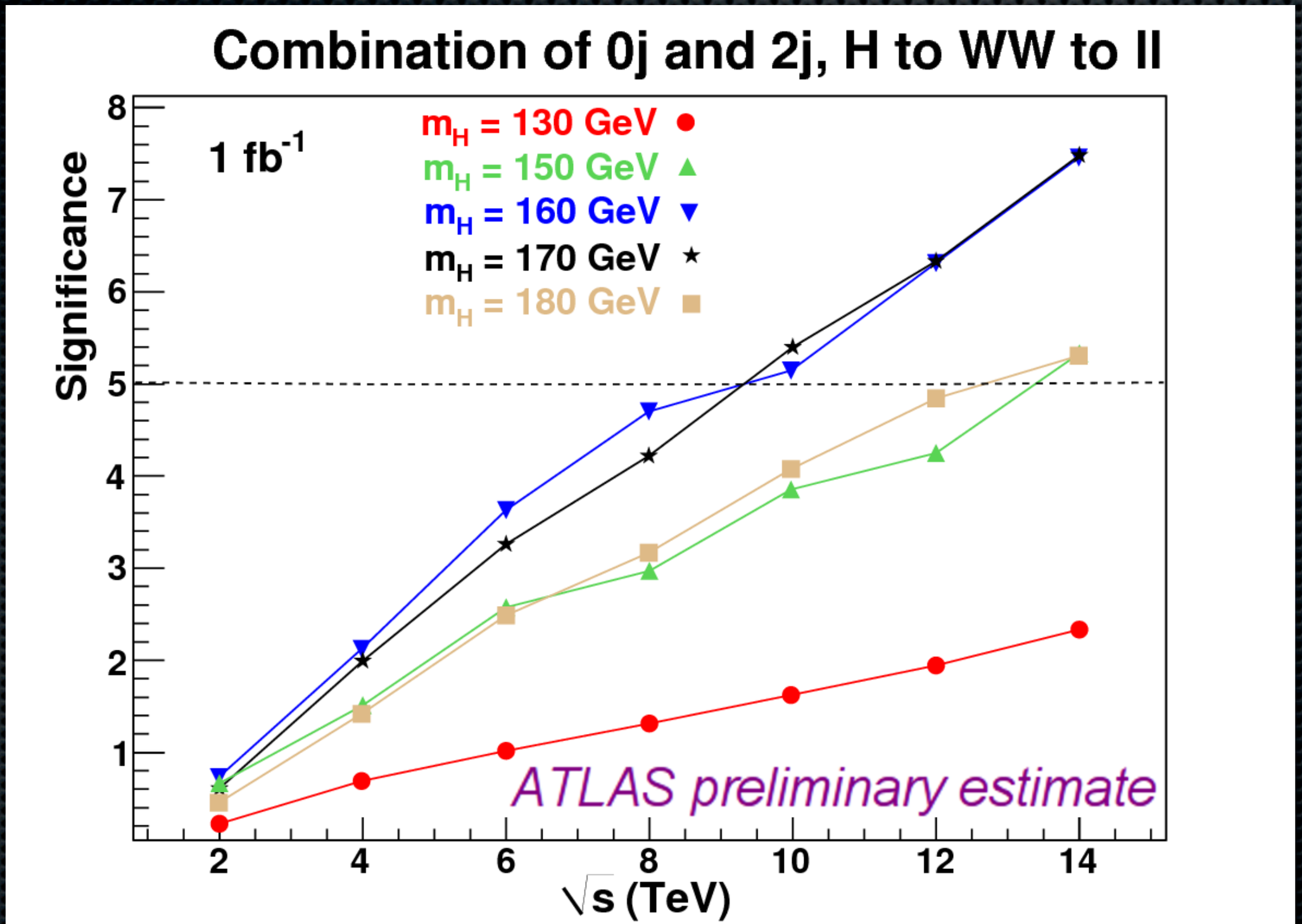
Summary and Outlook

- 2010/2011 Run Plan is to collect 1 fb^{-1} at 3.5 TeV x 3.5 TeV
- Possibilities with a 1 fb^{-1} dataset at $\sqrt{s}$ = 7 TeV:
  - ~250k Z → e e, ~6k top → ℓ+ jets
  - extend the discovery reach for W′, Z′
  - (some) Higgs sensitivity (2 experiments combined)

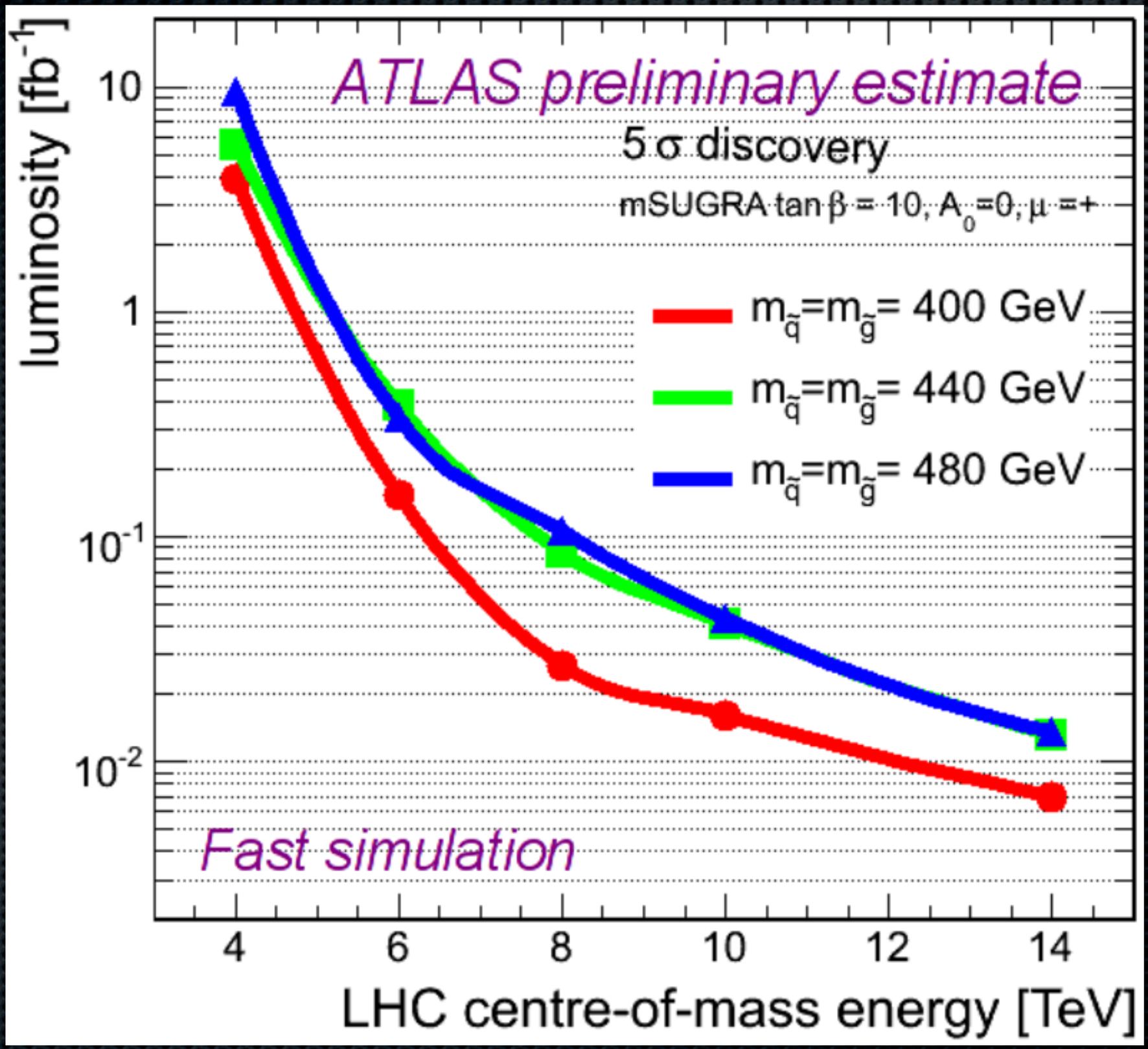
The excitement is coming again
soon, to a control room near you!

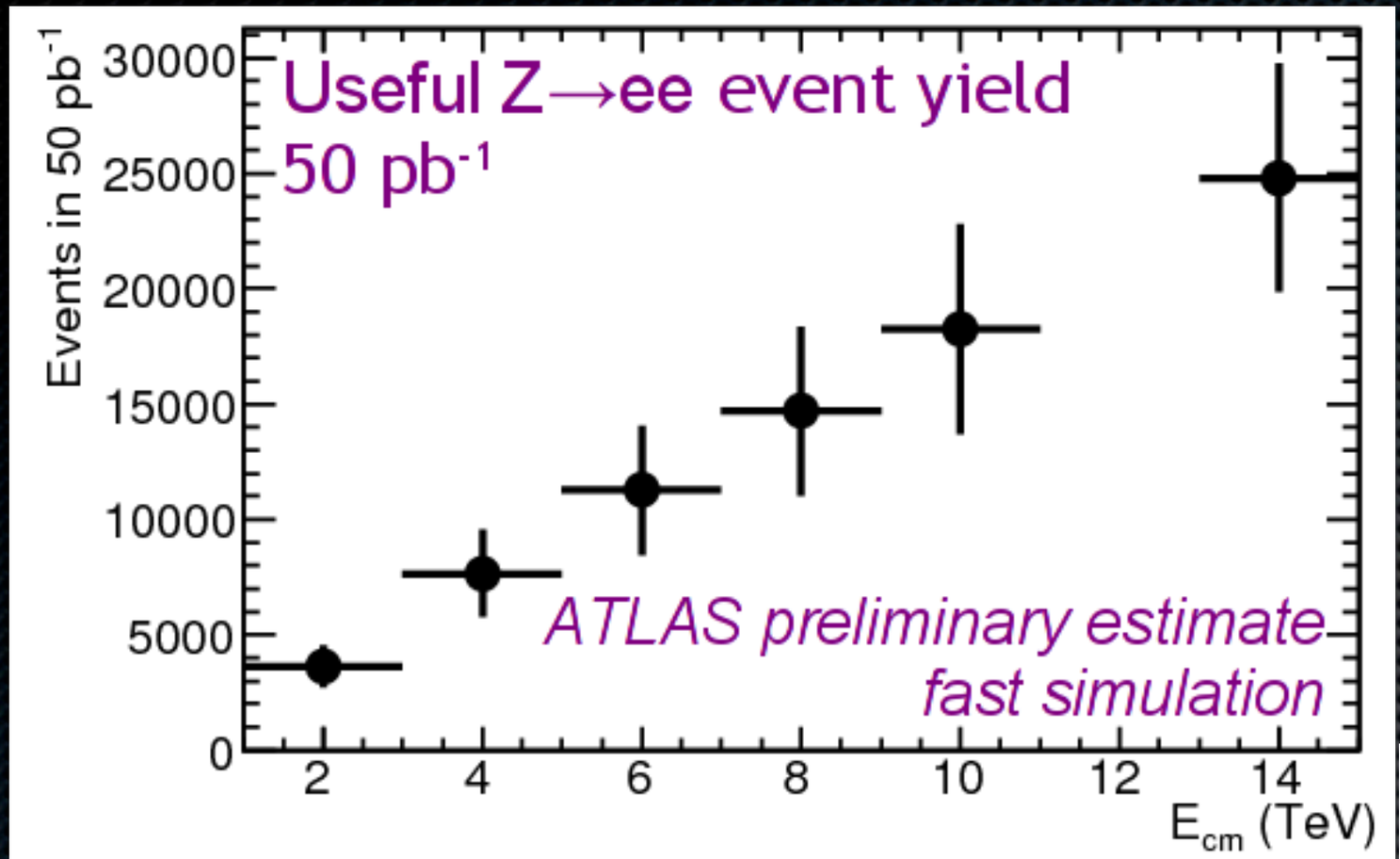
Additional Slides

Chamonix 2009

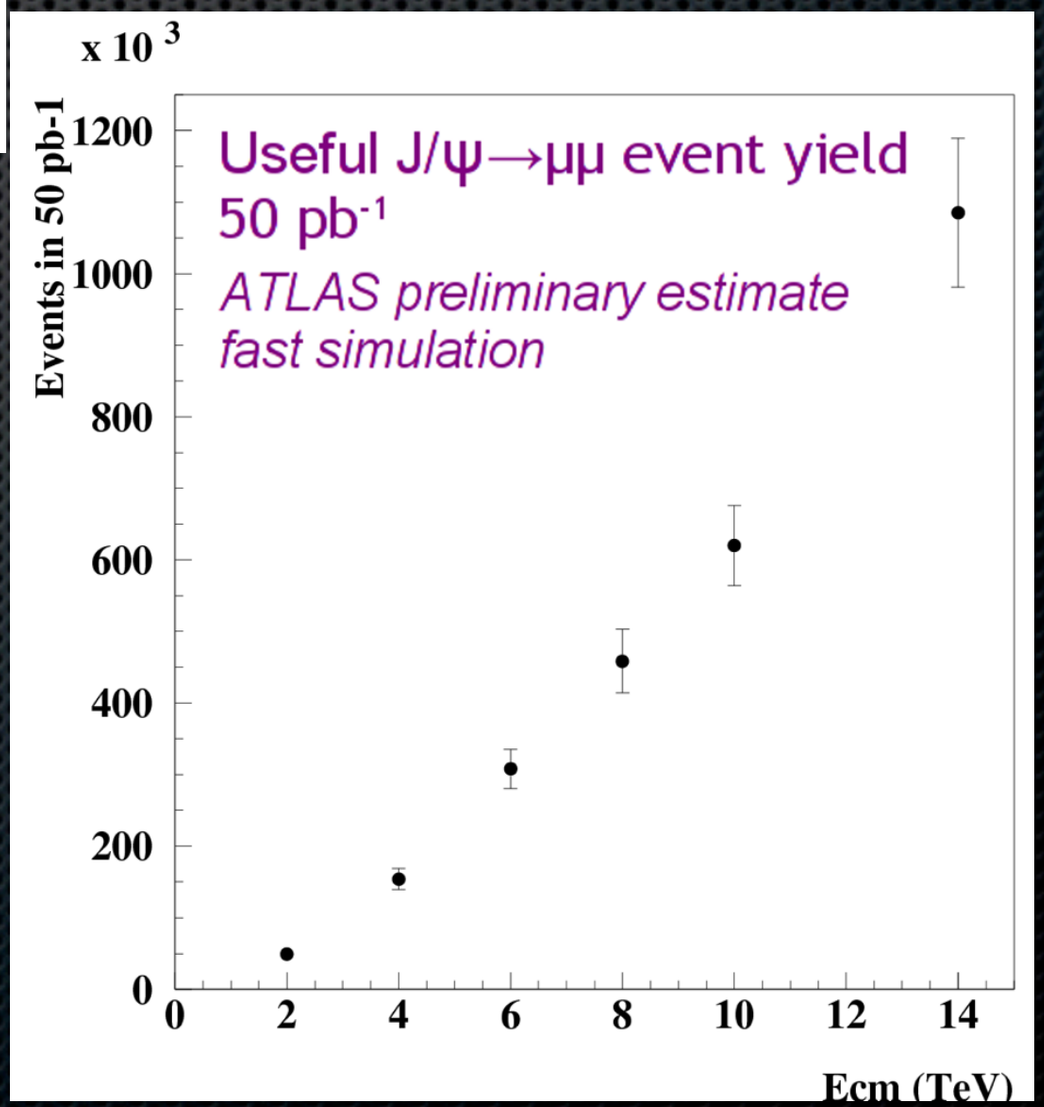


Chamonix 2009





Chamonix 2009



Calibration Samples